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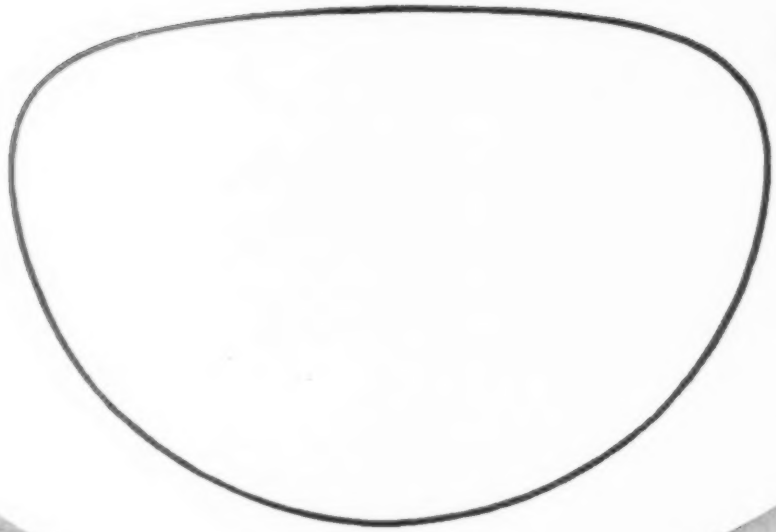
You *know* it's the



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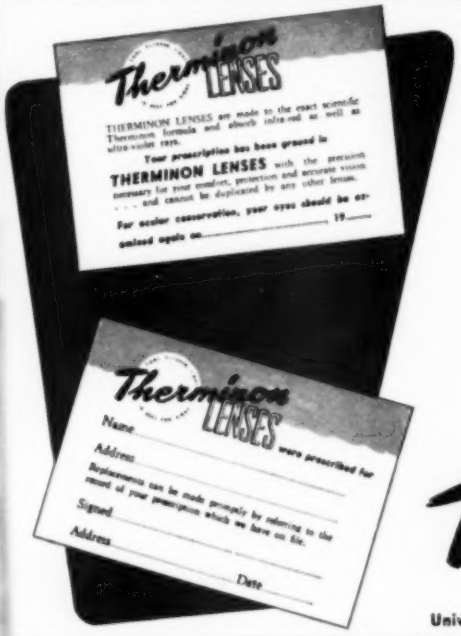
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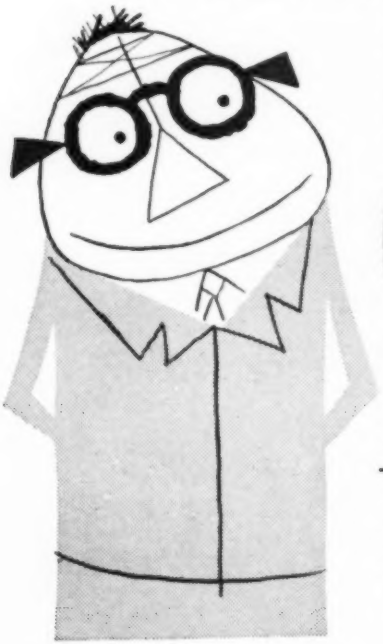

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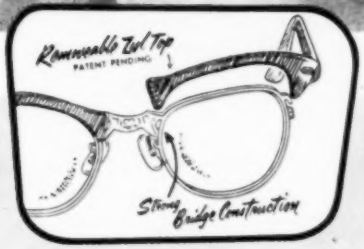

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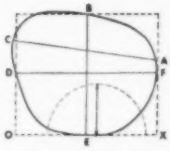

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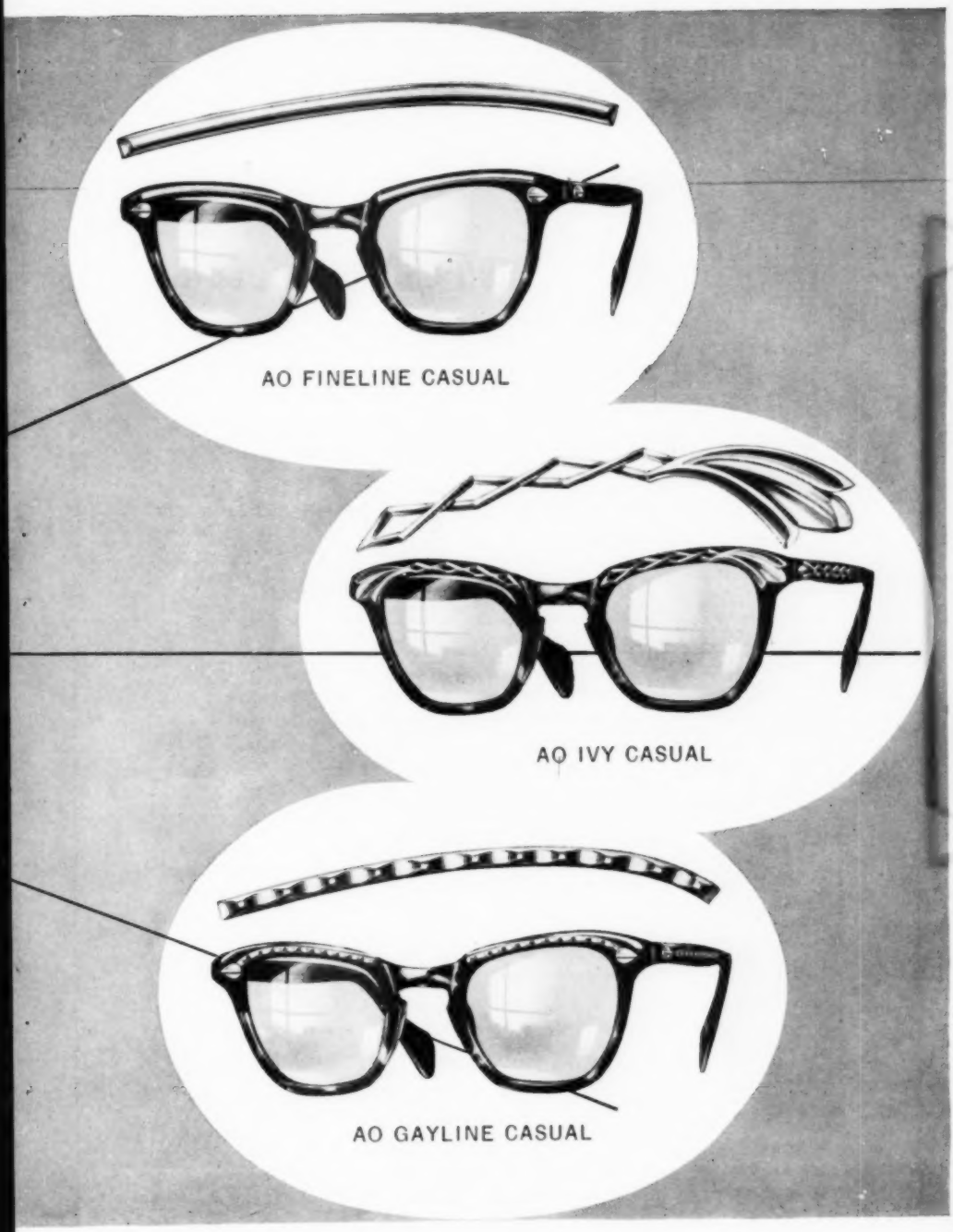
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Vol. 29 February, 1952 No. 2

RESEARCH IN VISION*

Sponsored by
The Office of Naval Research†

Henry A. Imus‡
Head, Psychophysiology Branch
Washington, D. C.

FOREWORD

During the past five years the Psychophysiology Branch of the Office of Naval Research has sponsored a program of fundamental research in the human senses—vision, hearing, taste, touch and smell, as well as the underlying physiology of the nervous system. Approximately half the current program is devoted to problems related to vision.

CURRENT RESEARCH PROJECTS

It is impossible to obtain agreement among physiologists and psychologists on an adequate definition of the term psychophysiology. Some deny that it is a good term. To avoid such conflicts, psychophysiology of vision will be defined here by describing experiments conducted by Selig Hecht and discussed by him in 1944 in an excellent presentation[1] before Sigma Xi. In his remarks concerning the relationship between physical energy and vision, he stated that Langley, in 1889, found that he (Langley) could barely see a light whose energy value was 3×10^{-9} ergs.§ According to the Planck Quantum Theory, 1900, each quantum of light used by Langley had an energy value of 3.6×10^{-12} ergs. Therefore, slightly less than 1,000 quanta of light were required to be just visible to Langley's eye. If we take into account the Einstein Photochemical Equivalence Law,** then for each quantum of

*An abridgement of the material presented at the annual banquet of the American Academy of Optometry, Chicago, Illinois, December 18, 1950. Submitted on July 16, 1951, for publication in the February, 1952, issue of the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.

†From the Human Resources Division, Office of Naval Research, Department of the Navy. Opinions or conclusions contained in this report are those of the author. They are not to be construed as necessarily reflecting the views or the endorsement of the Department of the Navy or the Naval Service at large.

‡Ph.D. Fellow, American Academy of Optometry.

§At sea level, it takes 1,000 ergs of energy to raise 1 gram 1 cm.

**For primary photochemical reactions, each quantum of energy is absorbed by a single molecule, which is then changed by it.

energy absorbed, one molecule is changed. Therefore, in Langley's experiment, to see a single, faint flash of light, approximately 1,000 molecules of light sensitive material underwent a chemical change.

Hecht, in repeating Langley's experiment under rigidly controlled conditions, found that Langley had been wrong by a factor of 10. By dark adapting the eye for one hour, by using an area 10 minutes in diameter and displaced 20 degrees off center from the fovea, and by exposing the eye to light of wave-length 510 millimicrons for 1/1000 of a second, Hecht was able to prove that approximately 100 instead of 1000 quanta were involved. Then, by taking into account the fact that 54 per cent of the light striking the eye is lost during transmission, he calculated that only 26 quanta of light reached the retina. In the retina area used in his experiment, (subtending 10 minutes of arc), there are approximately 500 rods, the external segments of which contain visual purple. Using the data of Koenig and Wald on the absorption of light by the visual purple, Hecht calculated that this minimal flash of light resulted in the photochemical transformation of one molecule of visual purple in each of 5 to 14 rods.

Finally, Hecht concluded from his experiments that the number of quanta in a given flash of light may vary by a factor of 2, and that the probability of seeing a minimal flash of light is a function not only of the response of the receptor mechanism but also of the number of quanta of light present in the flash.

In the following discussion, a number of research projects supported by the Psychophysiology Branch are described. At the Jenkins Laboratory of Biophysics of The Johns Hopkins University, H. K. Hartline[2] is continuing the research in the probability of seeing which he started at the Johnson Foundation at the University of Pennsylvania some years ago. The subject for Hartline's experiments is the excised eye of the horseshoe crab, Limulus. Neurologically, Limulus makes an excellent subject for experimentation because there are no synapses and ganglia between the single sense cell, which responds to light, and the corresponding optic nerve fibre which can be attached to a microelectrode under a microscope. By restricting the entering light to a single facet of the cornea of this cooperative beastie, it is possible to stimulate just one light-sensitive cell.

Using elaborate optical means for presenting a measured flash or flashes of light to the single sense cell, and then picking up the response with microelectrodes, it is possible to measure the response of the cell. Figure 1 shows the response of a typical single cell to light of five different intensities. The more intense the light, the more rapidly

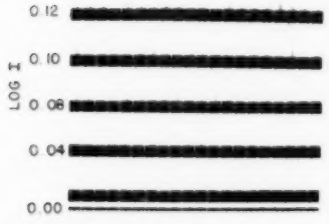

Fig. 1. Response of single sense cell of *Limulus* to light of five different intensities. (Courtesy H. K. Hartline.)

the cell discharges. Figure 2 shows the increase in sensitivity of the cell following different periods of dark adaptation from 30 seconds to one hour. There are twice as many discharges of the cell following 5 minutes in the dark as following 30 seconds in the dark.

Figure 3 shows the response to duration and intensity of the stimulus. A stimulus having an intensity of one-thousandth of unity exposed for one second produced the same response as a stimulus of unit intensity having a duration of one-thousandth of a second. These experiments, then, aid us in predicting the probability of seeing, based upon the response of the sense organ.

George Wald,[3] at Harvard Biological Laboratories, has been investigating the minute chemical transformations which take place in the eye, and especially in the pigments of the eye. Figure 4 is a schematic representation of the transformation of the visual purple by the action of light and its subsequent regeneration. In the dark, rhodopsin (visual purple) reaches its maximal concentration, which is associated with the

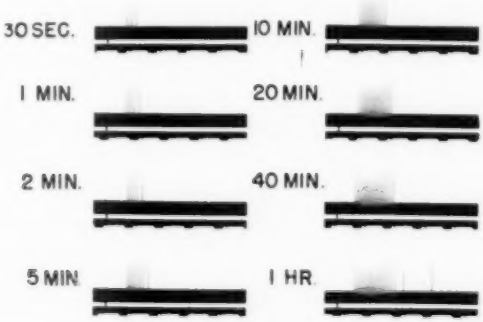

Fig. 2. Increase of sensitivity of cell following different periods of dark adaptation. (Courtesy H. K. Hartline.)

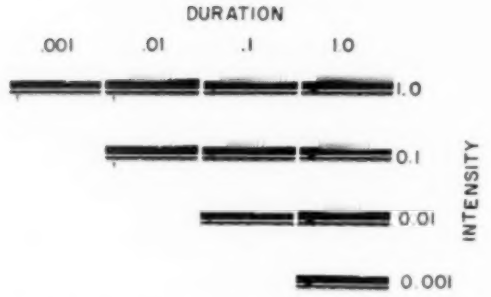

Fig. 3. Response to duration and intensity of stimulus. (Courtesy H. K. Hartline.)

rise of visual sensitivity to its maximum value. Under the action of light, the red-colored rhodopsin is changed to lumi-rhodopsin and then to meta-rhodopsin, with little change in its spectral color, forming a latent image upon the rods. It is probable that the excitation of the rods is accomplished by this latent image because the response in the optic nerve occurs so rapidly following the exposure of the eye to light. In the presence of water, this latent image is developed, the meta-rhodopsin going over to the yellow Retinene 1 and a protein called Opsin. This retinene, under the action of an enzyme called retinene reductase, DPN-H2, is reduced to Vitamin A (colorless) and the protein Opsin. The enzyme system introduces a second vitamin into the chemistry of rod vision, namely, nicotinamide, the anti-pellagra factor of the vitamin B complex. The actions are all reversible, and in the dark the rhodopsin* is regenerated. Such carefully controlled and precise measurements of chemical reactions are providing us with basic knowledge of the mir-

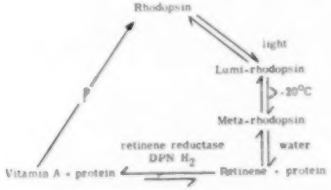

Fig. 4. Schematic representation of chemical transformations of Rhodopsin and its regeneration. (Courtesy George Wald.)

*For an excellent, non-technical, and well-illustrated discussion of this subject, see the article by Dr. Wald entitled "Eye and Camera" in the Scientific American for August, 1950.

Fig. 5. Electrode mounted in contact lens. (Courtesy L. A. Riggs.)

aculous performance of the human eye and are leading to important changes in our theory of vision.

Experiments on the intact human retina challenge the ingenuity of the scientist. Lorrin Riggs[4] of the Department of Psychology at Brown University, has succeeded in developing a unique method of picking up the electrical response of the human retina to light. A contact lens is fitted to the eye of the subject. Mounted on the lens is an electrode, with its wick resting on the cornea within the saline solution between lens and cornea. Figure 5 shows the subject in position with the recording leads attached to the electrode, and Figure 6 shows the arrangement of the apparatus.

While the subject is directing his attention to a fixation point in the center of a homogeneous surrounding field, a brief flash of light is pre-

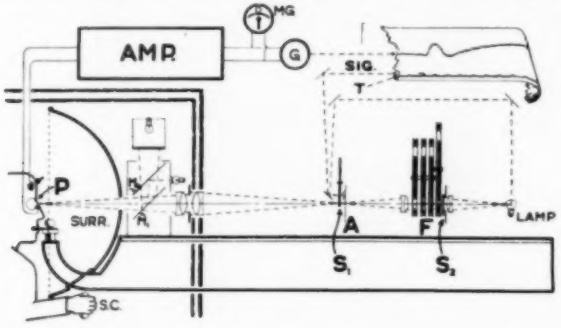

Fig. 6. Arrangement of the apparatus for studying electrical responses of retina to light. (Courtesy L. A. Riggs.)

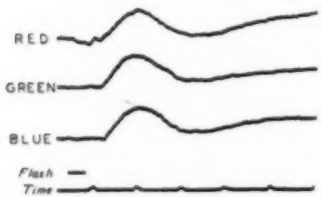

Fig. 7. Typical response records to red, green, and blue flashes.

sented to his eye, the duration of the flash of light being controlled by high-speed shutters and its wavelength by appropriate filters. The electrical response is recorded upon photographic paper along side of the time marker which indicates tenths of seconds. The flash automatically records itself as a signal mark on the same paper. Figure 7 shows typical records of response to red, green, and blue flashes. The curves are very similar in the light-adapted eye, and dark-adapted eye, and the electrical data fail to show the familiar Purkinje shift, suggesting that the electrical effects are primarily scotopic no matter how bright the stimuli or how high the level of light adaptation. Riggs concludes that dark adaptation takes place largely at the retinal level using the scotopic visual system.

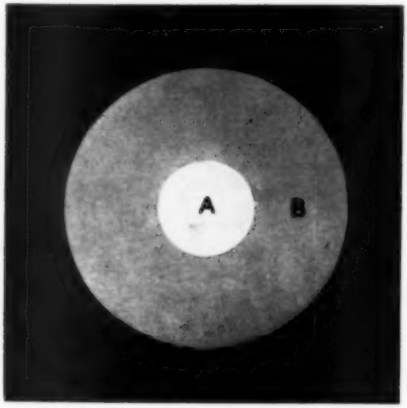

Fig. 8. Illustrates the situation for the visual discrimination of differences in intensity. When the intensity of the light within area A is increased by introducing a flash of light, an observer may or may not be able to discriminate a difference in brightness between the test area A and the background area B, depending upon the magnitude of the difference in intensity of the light in the two areas. This difference in intensity is designated as ΔI. (Courtesy C. H. Graham.)

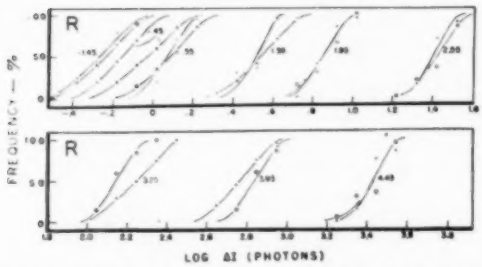

Fig. 9. "Frequency of seeing" represented as a function of Δ I for one subject R. Each curve was obtained twice and the logarithm of the prevailing intensity is indicated beside each pair of curves. (Courtesy C. H. Graham.)

At Columbia University, C. H. Graham[5, 6] has been directing a number of projects on visual intensity discrimination. He and his associates have studied this phenomenon utilizing a rather elaborate apparatus. While the observer is looking at a field of uniform brightness illuminated by a light source, a slight increase in apparent brightness is added to the central portion of his field of view from another light source. The intensity of the added light is controlled by optical wedges and the duration of exposure is controlled by a rapid shutter.

In Figure 8, the added center field of brightness, A, is bright enough; it can be seen against the larger field B. If the added brightness is inadequate, no central spot is seen. Whether it is seen or not is a matter of probability. When the increase is slight, the observer never notices it. As the brightness of A is increased, the probability of its being seen increases from 0 to 100 per cent, the latter being when the brightness of A is great enough so that it is seen every time. The difference in intensity between A and B which permits the central spot A to be seen 50 per cent of the time is called the threshold for $\triangle$ I.

A series of curves representing the frequency of seeing or visual intensity discriminations of one subject is shown in Figure 9, plotted for various levels of background intensity. They show that, for low

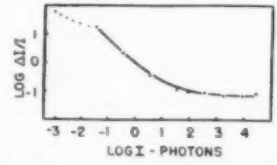

Fig. 10. Intensity discrimination as indicated by the ratio Δ I/I at various intensities of the background I. (Courtesy C. H. Graham.)

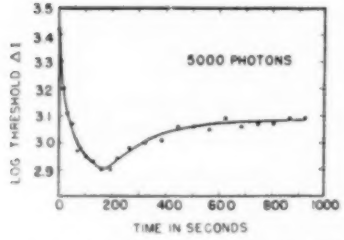

Fig. 11. Δ I as a function of time (in seconds) after the beginning of exposure to a prevailing intensity of 5,000 photons (i.e., a fairly bright light). (Courtesy C. H. Graham.)

levels, very little light has to be added in order to obtain a response from the subject 50 per cent of the time. For high levels, a great deal of light must be added before the threshold is reached.

The curve in Figure 10 was obtained by recomputing the data from Figure 9 and plotting the ratio of $\triangle$ I/I against the level of background illumination, measured in photons. This curve shows that intensity discrimination is poor at low levels of illumination ($\triangle$ I is large) and increases markedly as the prevailing background intensity increases to high values. The curve of Figure 11 shows that the discrimination of intensity is best about three minutes after the beginning of exposure to the prevailing background intensity. Poor initial response may be due to neural processes or to photochemical complications.

Richard G. Scobee of the Department of Ophthalmology, Washington University Medical School, St. Louis, is conducting research on heterophoria and heterotropia, subjects closely related to the field of in-

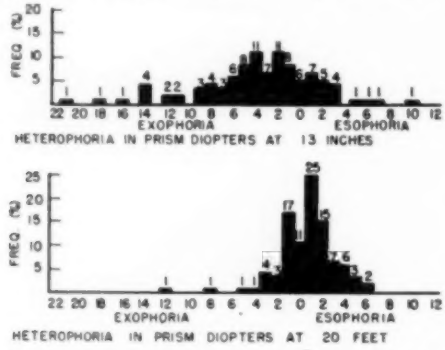

Fig. 12. Distribution of lateral heterophoria at 20 feet and at 16 inches for males 18 to 35 years of age inclusive. (Courtesy R. G. Scobee.)

terest of optometry. He has completed an examination of 1,215 school children, both by complete ophthalmologic examination and by the commercially available visual-screening devices. Report of this study will be issued as a Bulletin of the Children's Bureau of the Federal Security Agency.

In order to approach the problem of appropriate limits of heterophoria for acceptance into the military services, Scobee has been collecting data on unselected male populations between the ages of 18 to 35 years. Figure 12 illustrates one sample of population data. His combined data show that limits of 4 prism diopters of esophoria or exophoria at 6 meters will include 92 per cent of a general population. If the limits are set at 8 prism diopters, then 98 per cent of the population are included. At 33 cm., 85 per cent of the population show heterophoria ranging from 10 prism diopters of exophoria to 4 prism diopters of esophoria.

In a statistical study of hyperphoria.[7] Scobee was able to demonstrate the absence of a significant relationship between lateral phoria tested at 33 cm., or at 6 meters and hyperphoria at the same distances.

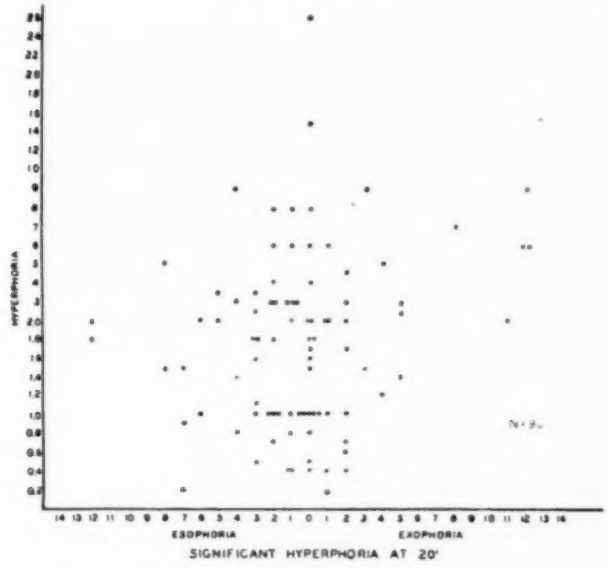

Fig. 13. Relationship between lateral heterophoria and hyperphoria at 6 meters or 20 feet for 90 patients. (Courtesy R. G. Scobee.)

The lack of relationship at 6 meters or 20 feet is illustrated in Figure 13.* In the series of 1,476 consecutive patients examined, only one in 20 showed a hyperphoria with associated symptoms. There was no significant relationship to age or visual acuity. Eighteen per cent of patients with clinically significant hyperphoria showed an increase in manifest hyperphoria after the prescription of prisms for constant wear. In the remaining 82 per cent, the hyperphoria stayed constant when the prisms were worn. Other reports, of interest but not discussed here, are available in the published literature.[8, 9, 10, 11]

In 1948, the Subcommittee on Visibility and Atmospheric Optics, of the Armed Forces-National Research Council Vision Committee, recommended that a research program be undertaken to determine the physical parameters limiting the visibility of submerged objects from the air. S. Q. Duntley, Professor of Physics at the Massachusetts Institute of Technology, who directed a similar project on the visibility of targets through the atmosphere at the Tiffany Foundation during World War II, was the logical choice for the Principal Investigator.

A field laboratory station[12] was established on Diamond Island at Lake Winnepesaukee, New Hampshire, in the summer of 1948. A

Fig. 14. View of tower and glass-bottom boat.

tower was constructed over the site of an old boat landing, Figure 14. Cameras, mounted at the top of the tower and in the bottom of a glass-bottomed boat moored at the base of the tower, were used to photograph targets submerged at various distances below the surface. Within the field of view of the tower camera, and close to the surface of the water,

*In the article appearing in the *Archives of Ophthalmology*, the legends for charts 3 and 4 were transposed.

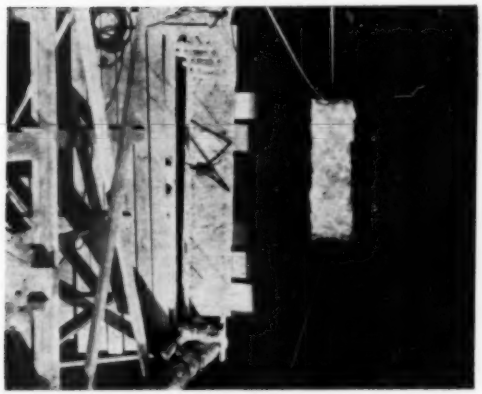

Fig. 15. View of submerged target and gray scale used for reference.

a gray-scale, Figure 15, was mounted to provide a standard for the densitometric measurements of the contrast attenuation by the atmosphere. The difference in contrast rendition between the image formed in the camera mounted in the boat and that of the image formed in the tower camera revealed the attenuation of contrast by the water and by the atmosphere.

In still water, the apparent contrast of the target seen by an observer in the tower can be predicted from the altitude of the sun and the relative amount of direct sunlight impinging upon the surface of the water. The former parameter can be measured readily, and the latter can be determined by reading a sky-state meter, developed by Dr. Duntley, mounted at the top of the tower. Mathematical formulation of the problem is illustrated in Figure 16, in which a target submerged at a distance d, having a reflectance of R, forms a contrast (C_0) with a water background of reflectance (R_w).[13]

When the water surface is rough, light reflected from the submerged

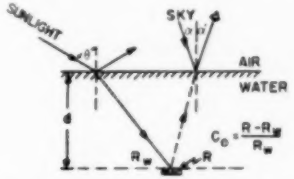

Fig. 16. Mathematical formulation of attenuation of contrast of a submerged target by the water.

target reaches the eye of the observer only part of the time. The time-averaged apparent contrast of the target can be shown to depend upon the state of the sea and the angle subtended by the target at the surface of the water. For example, in an extremely light breeze, when the surface of the water is barely ruffled, the time-averaged contrast is 0.63 of the apparent contrast in calm water. In the case of a 40-knot wind, however, the time-averaged apparent contrast of the same target is reduced to 0.095 of its calm-water value.

When the inter-relationships and relative importance of these parameters are known fully, it will be possible to predict the visibility of submerged targets.

In conclusion, the projects described are some representative samples of the research program supported by the Psychophysiology Branch of the Office of Naval Research. The aim is to discover basic facts, for it is only from basic facts that new ideas and developments arise. During the past 20 years, ophthalmology has progressed tremendously through emphasis upon basic research in the anatomy, neurology, and physiology of vision. Similar results can be obtained in optometry by the encouragement of qualified students to pursue graduate work in allied basic sciences, and by sponsorship of research projects by competent, creative men with ideas.

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A BRIEF HISTORY OF "NOCTURNAL MYOPIA" AND RELATED PHENOMENA*

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INTRODUCTION

In the past decade studies in this country and abroad have indicated an increase in the refractive state of the eye to be associated with a reduction in the level of luminance of the test field, the so-called "nocturnal or night myopia." The refractive state of the eye is found to increase as the test field luminance decreases.

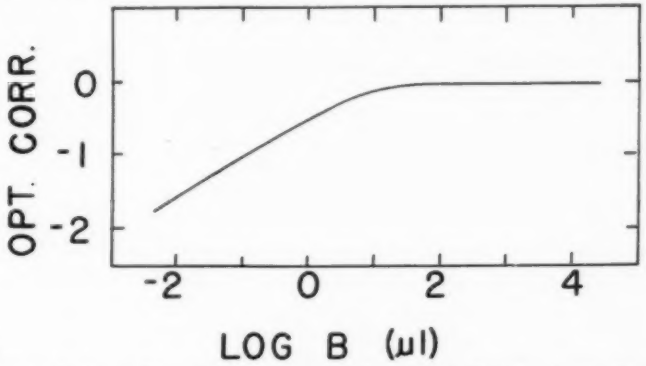

Fig. 1. Optimum Spectacle Correction as a Function of Field Luminance (microlamberts). The correction is relative to the high luminance correction. (These data are reproduced here with permission of Dr. R. Tousey, Naval Research Laboratory, Washington, D. C.)

Figure 1 shows a typical trend of the optimum dioptric correction for the entire range of luminances from daylight to total darkness, using the daylight correction as the zero value (these data are reproduced here by permission of Dr. Richard Tousey, Naval Research Laboratory, Washington, D. C.). The data represent the relationship as determined with four observers for the resolution of a grating test target of fixed contrast. Schober has determined essentially the same relationship for

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28 observers using binocular eyepiece settings while observing landscapes out of doors. Schober's average curve does not show a flat portion, but slopes continuously from the highest value of field luminance to the lowest. It can be seen that at the lowest luminance measured by Tousey (Koomen, Scolnik, and Tousey), the "myopia" is roughly —1.50 diopters. The highest values for his observers varied between —1.0 and —2.0 diopters. The "myopia" shown by Schober's subjects varied from —0.5 to —4.0 and averaged —2.0 diopters.

In addition to the "nocturnal myopia" there has also been reported the so-called "nocturnal presbyopia." The experimental findings indicate a considerable closing in of the far point combined with a slight recession of the near point resulting in a reduction of the apparent amplitude of accommodation when the level of luminance is reduced. At the lowest levels the apparent amplitude is reduced to zero and the eye assumes a state of apparent fixed focus.

Possible factors contributing to "nocturnal myopia" include the following:

(I) Longitudinal chromatic aberration combined with the Purkinje Shift in spectral sensitivity. According to theoretical calculations, this may account for roughly —0.50 diopters of the effect.

(II) Spherical aberration in conjunction with the Stiles-Crawford Effect. As the level of luminance is reduced the pupil dilates and exposes the more myopic zones of the lens, these zones being fully effective since the Stiles-Crawford Effect is absent in scotopic vision.

(III) Changes in accommodation resulting from manipulation of the form and/or position of the crystalline lens. Two theories have been presented to explain these changes in accommodation.

(A) Ivanoff claims that at low levels of luminance as well as at high levels, the eye will change accommodation to compensate for minus lenses added to the distance correction. In other words the apparent need for minus lenses does not represent compensation for accommodation induced by low levels of luminance, but rather the minus lenses themselves induce accommodation. This accommodation tends to eliminate the spherical aberration of the eye, and in this manner the eye becomes essentially aplanatic. The optimum spectacle correction for seeing at low levels of luminance and the magnitude of accommodation required to eliminate spherical aberration agree rather closely and it is this agreement that is one of the main arguments in the support of Ivanoff's theory.

(B) The "resting" or "basic" adjustment of the lens does not correspond to the far point as usually measured, but to the position as-

sumed by the eye in total darkness. This implies the need for negative accommodation to render the retina conjugate to its photopic far point.

This second possible cause of changes in the form of the crystalline lens has also been proposed by Luckiesh and Moss as a possible cause for the increased refractive state associated with freedom from optical stimulation of accommodation. As a matter of fact, the two situations (reduced luminance and absence of optical stimulation) are in many respects quite similar. At the lowest level of luminance, that is, in complete darkness, both situations would be completely analogous, except for the difference in adaptation level and pupil size, since in each case there is a complete absence of optical stimulation of accommodation.

HISTORY

As early as 1883 Lord Rayleigh wrote, "I have found that in a nearly dark room I am distinctly short-sighted. With concave spectacles of 36 inches negative focus my vision is rendered much sharper, and is attended with increased binocular effect." If we may assume that he was an emmetrope and that the above was his optimum correction, his value of approximately —1.1 diopters is in very good agreement with the most recent values. In an attempt to explain this effect, Lord Rayleigh proposed the effect of the known spherical aberration of the eye and the dilatation of the pupil at low levels of luminance.

Five years later, Jackson investigated retinoscopically the refractive power of various zones of the eye and concluded that the increased refractive power at low levels of luminance was due to the spherical aberration which became manifest as the pupil dilated. He gives the frequencies shown below for the differences in refraction between the outer and central zones of the lenses which he measured.

Difference in Power	*Frequency*
—1.00	2
—0.50	7
±0.25	13
+0.50	44
+1.00	19
+1.50	9
+2.00	4
+3.00	2

Although he gives no quantitative data concerning the magnitude of "nocturnal myopia," he suggested that the high incidence of a positive difference could explain the increased refractive power of the eye in night vision.

In 1918, Ogata and Weymouth sought to explain in another manner the myopia noticed by Weymouth at night. Using the definition of the acute angle of an isosceles triangle as a criterion, they determined the best correction for seeing with the fovea and at various angular distances from the primary line of sight. In the annular zone 3 to 5 degrees from the fovea they found an average myopia of 0.37 diopters. This they explained as an effect due to the presence of the external fovea. The effect was equal for several sizes of artificial pupils and when the eyes measured were instilled with homatropine. They concluded that the myopia noted at night was due to this effect, but conceded that the myopia noted in the central fovea could only be explained by the spherical aberration theory.

Wibaut in 1921 reviewed some of the work and theories of "nocturnal myopia." He refers to Baraneck and Verrey, who in 1893 found the effect to amount to between —0.33 and —0.25 diopters, and Charpentier, who in 1902 found it to vary between —0.50 and —3.00 diopters. Independently these investigators proposed an explanation based on the assumption that light produces a strong filling of the chorioidal vessels, thus producing a condition of relative hyperopia in going from low levels to high levels of luminance.

According to Wibaut, Schoute (1903) was not able to demonstrate any "nocturnal myopia."

Wibaut measured the effect to amount to —1.50 diopters and subscribed to the combined theory proposed by Ogata and Weymouth, although he does not present any data of his own to substantiate this stand.

Probably one of the earliest investigations concerning what has come to be known as "nocturnal presbyopia" (a reduction in the apparent amplitude of accommodation) is the work by Ferree and Rand published in the early thirties. At that time these workers examined the effect of reduced illuminance upon the near point of accommodation. Using as their extremes, 0.5 and 100 foot candles, they found a change in the near point from 10.35 cm. to 9.04 cm. in a 23-year-old subject, and a change from 61 cm. to 22.5 cm. in a 52-year-old subject. Although these are relatively small effects, it must be remembered that the illuminance range covered is also relatively small, approximately 2 log units as compared with 6 log units covered by later workers.

In 1941 Otero and Duran of Madrid, Spain, published a paper on the various factors which contribute to the efficient performance of optical instruments. Among other factors they reported the ocular settings at low luminances as being negative relative to the settings made

at high levels. In this paper they proposed the effect of spherical aberration as the explanation of the phenomenon.

Since 1941 numerous papers have appeared by Otero and his coworkers (Cabello, Duran, Jimenez-Landi, Plaza, Rios, and Salaverri) on the various aspects of the problem. The following is a brief, chronological summary of their work.

In a second study by Otero and Duran it was shown that when homatropine was instilled in the eyes of subjects who under normal conditions demonstrated considerable "nocturnal myopia," no myopia was evident. One absolute presbyope was used as a subject and demonstrated no "nocturnal myopia." The conclusion was that the spherical aberration theory could only account for approximately 0.5 diopters and the rest had to be accounted for by an accommodative change—in this case explained by the effort to reduce the spherical aberration. The eye is undercorrected for high values of accommodation. At some value the eye is roughly aplanatic. This value turns out to be roughly 1.5-2.0 diopters of accommodation.

This theory was abandoned when in 1943 Duran showed experimentally that the apparent amplitude of accommodation is reduced to zero at a luminance level of about 0.0003 c/m.^{2} The reduction in the range of accommodation was an extension of Ferree and Rand's earlier work and was substantiated by Palacious in Portugal and Wald in this country.

At about the same time Otero and Duran had postulated a theory in which the chromatic aberration of the eye and the shift in sensitivity from 555mu to 510mu in going from photopic to scotopic vision might account for approximately 0.25 diopter of the "nocturnal myopia." This effect has been substantiated by Ronchi and Wald. The latter's measurements indicate that this effect could account for as much as 0.59 diopters. Otero and Duran could now account for roughly 0.75 diopters of the effect in terms of spherical and chromatic aberrations—the remainder was attributed to some anomaly of accommodation.

In 1945, Cabello reported an increase in "nocturnal myopia" as a function of time in the dark. The increase shown was very rapid for the first five minutes, remaining relatively constant (—1.5 diopters) for about 10 minutes and then in the next five minutes approaches —2.0 diopters as a limit. The early change was not attributed to a specific cause, but the last 0.5 diopter change was attributed to the effect of chromatic aberration and the shift in sensitivity to the blue end of the spectrum. The method of measuring the state of refraction in this experiment was not stated very clearly, but it is believed that in all

cases the correction was determined by means of finding the optimum correction for foveal acuity. This method has the objection of restimulating the retinal elements at intervals and thus varying the state of adaptation of the retina.

A point which was not considered in the paper is the finite time required for pupil dilatation. According to Reeves[1] this covers a period of about three minutes. The early increase in refraction might be explained by this pupil dilatation and the resulting effect of spherical aberration.

The most recent theory held by Otero and his group is that the increase in refraction is due to a combination of the aberrations and a "position of the lens of the eye" at low levels of luminance which does not correspond to "zero" accommodation. This they refer to as the natural position and corresponds to an accommodation for an object at 1 meter.*

According to this theory accommodation for the far point would require a negative action of the accommodative mechanism relative to the sense in which it is usually thought of.

Tousey and his co-workers (Koomen, Scolnik and Tousey) at the Naval Research Laboratory, Washington, D. C., have been working on the problem of "nocturnal myopia" since 1943 and have data which lead them to attribute the entire "myopia" to spherical and chromatic aberrations. The effect of chromatic aberration has not been directly investigated by them, but they base their estimate of its effect on Wald's data and thus account for approximately 0.3 diopters of the effect in this manner.

They believe that the outer zones of the lens contribute to the effect substantially not only because of the dilatation of the pupil, but also because of the absence of the Stiles-Crawford Effect in scotopic vision. The Stiles-Crawford Effect has been shown to hold only for cones and thus for increasingly larger pupils the outer zones of the lens would become relatively more and more important in establishing the scotopic focus. In essence their theory resolves itself into the following generalization: it is most efficient for the accommodative mechanism to focus the tip of the lens caustic on the retina in photopic vision, but to focus the circle of least confusion on the retina in scotopic vision. Since the circle of least confusion lies in front of the retina, minus lenses are required to bring this portion of the bundle in coincidence with the retina.

[1]Reeves, P., The Response of the Average Pupil to Various Intensities of Light, J.O.S.A., 4, 35-43, 1920.

*Personal communication from J. M. Otero.

Koomen, Tousey, and Scolnik[2] have very accurately measured the spherical aberration of their own eyes at various levels of accommodation. They have also measured the spherical aberration of the eye while accommodation was paralyzed with homatropine. The spherical aberration was reduced by the action of the homatropine in two of the three subjects. The results of these and other related experiments have led to the following conclusions:

(1) The magnitude of "nocturnal myopia" correlates fairly well with the magnitude of spherical aberration for the three subjects.

(2) The "nocturnal myopia" is reduced by the homatropine in those subjects whose spherical aberration is reduced by the use of the drug. The subject whose spherical aberration was not changed by the use of homatropine showed no change in his "nocturnal myopia" when the drug was used.

(3) When the pupil diameter was controlled by means of a three millimeter artificial pupil, the amount of "nocturnal myopia" was reduced to approximately 0.50 diopter. This was assumed to be due to chromatic aberration combined with the Purkinje Effect.

(4) By means of a schematic eye having positive spherical aberration it has been shown that different planes of the converging bundle are optimum for various sized targets. The optimum focus approaches the lens as the size of the target increases. They have thus demonstrated "nocturnal myopia" in their schematic eye.

Ivanoff, drawing on some earlier techniques and results of Le Grand, has measured the chromatic aberration of 11 eyes and he has also measured the spherical aberration of 10 eyes at various levels of accommodation. His results lead him to an explanation of "nocturnal myopia" in terms of the observed chromatic aberration and the Purkinje Effect and a "voluntary" effort of accommodation to eliminate the spherical aberration. The latter constitutes the explanation given earlier by Otero, but later abandoned.

The measurement of chromatic aberration was done at three wave-lengths (452.5 mu, 514 mu, and 712 mu) and the average values agree very well with the mean values found by Wald. This is especially significant since they used entirely different methods to determine the aberration. Their values agree closely with those made by additional investigators (see Wald) and it must be assumed that the measurements of the chromatic aberration of the eye are well established. Ivanoff concludes that the theoretical myopia of 0.5 diopter due to this aberration

[2]Koomen, M., Tousey, R., and Scolnik, R., Spherical Aberration of the Eye, J.O.S.A., 39, 370-376, 1949.

and the shift in spectral sensitivity constitute the only true myopic component of the so-called "nocturnal myopia." Thus it would seem that all principal investigators of the problem agree at least with the explanation of this portion of the "nocturnal myopia."

Ivanoff's measurements of the spherical aberration at various levels of accommodation agree in general with those of Koomen, Tousey, and Scolnik. Their results differ in that: (1) Ivanoff's measurements show a large amount of aberration within the central 2 millimeter zone of the lens, in fact for most of his observers the largest portion of the aberration is due to this small central zone. (2) His data show that the effect of accommodation is very pronounced in eliminating the aberration at a level between 1.5 and 2 diopters. Koomen, et al, found a similar effect, but only at much higher levels of accommodation (see Koomen, Tousey and Scolnik for a discussion of these differences).

Ivanoff believes that the "nocturnal myopia" is not an ametropia, but an accommodative adjustment in response to minus lenses, the noted magnitude practically eliminating the spherical aberration.

In an attempt to conciliate his theory with Cabello's experiment on the increase in "nocturnal myopia" with time in the dark, he reasons that the eye need not form a "sharp image" on the retina for optimum seeing until the point is reached where the differential sensitivity begins to decrease. This level of adaptation would only be reached some considerable time after the eye had been pre-adapted to a given relatively high luminance.

Schober has taken data on the binocular (7x50 and 8x60) eyepiece settings of 28 subjects over a large range of luminances. The observations were made monocularly for both eyes of each subject at sea and in the Austrian Alps. The results of his study may be summarized as follows:

(1) The average value of the difference between the high and low luminance settings is —2.0 diopters. The range for all observers was —0.5 to —4.0 diopters (Wald gives the range for 21 observers as +1.4 to —3.4. Katz gives values as high as —6.0).

(2) There are considerable variations for a given observer and the average values for the two eyes are not necessarily the same.

(3) No relationship exists between the magnitude of the measured "nocturnal myopia" and age. Two absolute presbyopes, aged 76 and 72 demonstrated 1.5 and 1.0 diopters of "nocturnal myopia" respectively.

(4) There is a gradual increase in "nocturnal myopia" as the

luminance decreases. (This does not agree with Tousey's data, see Figure 1.)

Schober concludes that a "psychic" accommodation must be the cause of the largest portion of the observed "myopia" at low levels of luminance. This accommodation is the result of an effort on the part of the observer to see when there is no accommodative stimulus present to "fix" the level of accommodation. In order to account for the "myopia" demonstrated by the two presbyopes, he admits that the spherical and chromatic aberrations must contribute at least a part of the total value of the "myopia."

He postulates further that: the uncorrected "myopia" reduces the absolute threshold, and lowers the visual acuity, whereas the corrected myopia raises the absolute threshold and improves the visual acuity. This is in agreement with the measurements of visual acuity made by Tousey, but is not verified by Tousey and Otero with regard to absolute thresholds. Schober bases this theory on a suggestion that the retinal illuminance distribution in the case of uncorrected "nocturnal myopia" as calculated from measured spherical aberration serves the same purpose in the human eye as does the tapetum lucidum in certain nocturnal animals. The resulting distribution on the retina for a point source is roughly a bright central spot, surrounded by a diffuse disc. The energy in the disc, he says, would be sub-threshold, but serves to lower the threshold for the central spot.

Ronchi, one of the earliest proponents of the chromatic aberration, Purkinje Effect theory of "nocturnal myopia," has recently proposed an entirely new theory to explain the increased refractive state of the eye at low levels of luminance. The theory involves the action of the pupil, which tends to modify the accommodative mechanism in two ways when it dilates. When the pupil dilates it allows the lens to move forward, and in so doing the iris presses on the periphery of the lens, forcing the central portion of the lens to bulge. These actions, according to Ronchi, are sufficient to explain the "myopia" over and above the 0.5 diopters explained by the chromatic aberration theory.

This theory, as pointed out by Ronchi, would explain Cabello's findings relative to the increase in "nocturnal myopia" with time in the dark. The early rise in refractive power would be due to the combined action of the dilating pupil, whereas the later, small increase would manifest itself as a result of the rod adaptation. He gives no reasons why this effect is not brought about by the use of cycloplegics.

The above summary of the many papers concerning so-called "nocturnal myopia" is not meant to be complete in the sense that it covers

all the aspects of the problem. An attempt has been made to review the more significant works as they relate to the basic facts and in the way which they relate to the overall problem of the state of refraction of the eye at low levels of luminance and in the absence of optical stimulation of accommodation. The history of the second phase of the problem will now be briefly reviewed.

In 1937 Luckiesh and Moss devised a method of refraction involving a technique which avoided stimulating accommodation optically, their so-called sensitometric method. This method involves the control of convergence by means of a blurred line visible to both eyes at distance, while increasing the luminance of the field and the contrast of a bi-concave test object until the test object first becomes visible. This is accomplished by observing a convergence target through the Luckiesh-Moss Visibility Meter and spherical lenses of various powers. The gradient filters of the meter are set to a point where the test target is invisible and are then rotated until the target is just visible. In this manner the sphere power of maximum visibility is determined in such a manner that accommodation is not stimulated until the setting is completed. Using this technique they found in 100 subjects that the correction for maximum visibility was between 0.37 to 1.37 diopters more negative, or less plus than the correction found using the usual subjective clinic procedure. The overall average for this group of observers was 0.75 diopters.

Luckiesh and Moss explained this effect by postulating a position of rest of the accommodative mechanism which does not render the retina conjugate with the usually measured far point, but rather with a point 0.75 diopters from the eye. In order for an emmetrope to see clearly at infinity, he would be forced to exert 0.75 diopters of negative relative accommodation. They suggest that this might be brought about by the sympathetic nervous system. Accommodation for points closer would be brought about by the action of the parasympathetic nervous system. It will be noted that this is similar to the theory recently proposed by Otero to explain the major portion of the "nocturnal myopia."

They give as further evidence in support of their theory the results of fatigue measurements (blink rate) for emmetropes wearing no correction and wearing minus corrections while performing visual tasks at infinity. These results indicated that the wearing of minus lenses reduced the fatigue.

Reese repeated the experiments of Luckiesh and Moss using 25 subjects and found essentially the same results. He did not use a binocu-

lar fixation line, the subjects simply fixated monocularly the center of a uniformly illuminated field. His subjects demonstrated an average "myopia" of 1.00 diopter with a total range from —2.00 to +0.25 diopters. When atropine was instilled, he found that there was no difference between the subjective clinic findings and the sensitometric findings. This result would tend to support the theory that the "myopia" is brought about by hypertonicity of the parasympathetic activity and that accommodating for infinity is simply an inhibition of this activity.

In an effort to test this reasoning Reese and Fry determined the state of accommodation when the eyes were fogged with plus spheres. They measured 12 subjects under various degrees of fog. As a fixation target they used a Snellen Test Chart. The results indicated three types of accommodative response to increased blurring with plus lenses. (a) The subject relaxes more and more accommodation as the fog is increased—only one subject of this type was found, (b) the subject maintains the same level of accommodation for different amounts of fog, and (c) the subject reacts to an increase in fog by permitting more accommodation to come into play.

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ANNOUNCEMENT

ASSOCIATION OF MILITARY OPTOMETRISTS OF THE UNITED STATES

Members of the Association of Military Reserve Officers, organized a year ago, met in New York City December 15, 1951, approving a constitution and electing officers for 1952. This group was formed to function for the interests of optometrists in the present national emergency.

Officers elected were: Dr. Eugene Strawn, Freeport, Illinois, president; Dr. D. R. Reed, La Porte, Indiana, secretary-treasurer. Executive council—Dr. Harold Fisher, New York City (Army), Dr. Raymond Roy, Portland, Oregon (Air Corps), and Dr. John E. Martin, Carroll, Iowa (Navy).

The constitution as now approved provides for membership for men who are commissioned by other allied powers, as well as for optometrists in the United States.

The goal of this group is the adoption of a policy by the Services of using optometrists for refracting duty only in commissioned status. Any optometrist eligible and interested in joining the Association should write to Dr. D. R. Reed, Secretary, Association of Military Optometrists of the United States, 204 Masonic Temple Building, La Porte, Indiana.

EFFECT OF MULTIFOCAL LENSES ON CONVERGENCE*

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The convergence of the eyes for near vision involves three components. They are:

1. accommodative convergence
2. fusional convergence
3. psychic convergence

Of the three, accommodative convergence is the only component which is elicited by accommodation. The stimulus for fusional movements is a disparity of retinal images in the two eyes while the awareness of nearness of the fixated object is the stimulus for psychic convergence.

In any act of convergence, the contributions of the three components vary. Thus, if accommodative convergence is small, a greater amount of fusional convergence is necessary for single binocular vision. Conversely if accommodative convergence is relatively large, only a small amount of fusional convergence is necessary. Although these findings have been known for some time, their clinical importance in the prescription and use of multifocal lenses has not been adequately recognized. It is for this reason that the present paper was written.

In the past, opinions differed as to the amount of contraction of the ciliary muscle required to produce 1 diopter of accommodation in presbyopia. One school of thought maintained that the same amount of contraction was required at any age; the other claimed that a greater contraction was necessary. According to this latter view, advanced presbyopia would require a maximal contraction of the ciliary muscle to produce, for example, 2 diopters of accommodation if this were the total amplitude. Fortunately, sufficient research has now been completed to indicate that although the presbyope can only avail himself of a small amplitude, the effort for each diopter is approximately the same as that for a young person with a larger amplitude.[1, 2]

The prescription of a multifocal lens always involves the addition of plus power as an add for use at near distances of fixation. For a given distance of fixation, the add represents the amount of accommodation

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which is not used in contrast to the amount required of an individual without an add and with ample accommodation. Since the stimulus for accommodative convergence is accommodation, a decrease in the amount of accommodation decreases the accommodative convergence. Thus, if one required a +2.50 D. add for a working distance of 40 cms., no accommodative convergence would be available to aid in the maintenance of single binocular vision.

In order to measure accommodative convergence, several different methods can be used. One of the simplest of these involves the use of two near phoria measurements. First, the near phoria is determined in the regular manner with particular emphasis upon the accommodative status. During the test the patient constantly should be urged to keep small or fine print as clear as possible. Then +1.00 D. spheres are added and the phoria again measured. The difference between the phoria measurements is the amount of accommodative convergence associated with 1 diopter of accommodation. This ratio frequently is called the accommodative-convergence accommodation ratio, or more simply the ACA ratio.[4, 5, 7]

At first consideration it may be thought that the addition of the +1.00 D. spheres would affect the amount of psychic convergence due to the slight enlargement of the retinal image. If this were true, then, the method does not provide a measure of only the ACA ratio. To date, however, all evidence indicates that the psychic convergence is the same in the two situations.[3]

Since the effort for the presbyope to accommodate 1 diopter is the same as that for a young person with a larger amplitude, one would expect their ACA ratios to be of equal size. That this is the case has been demonstrated by the accumulative results of a number of investigators. Hofstetter, for example, was unable to demonstrate any qualitative correlation between the ACA ratio of 76 subjects (as measured with a haploscope) and age.[2] Alpern and Hirsch studied the ACA ratio of a small group of observers measured over an extended period of time under conditions which permitted adequate control over the measurement of the amount of accommodation in play.[9] They also made a statistical analysis of the ACA ratio as determined by distance and near phorias for different age groups.[10] These studies indicated that there only is a slight but significant decrease in the ACA ratio with age. For the group employed in the statistical analysis, this decrease amounted to 1.2△ over a 40-year span, or 0.03△/year. A similar decrease was found by Hofstetter in an investigation of the ACA ratio in twins.[11] The significance of the slight decrease has not been experimentally determined.

However, one possibility is that it is an artifact of the method used to measure the ACA ratio clinically.[12]

Recently, Morgan and Peters determined the ACA ratio in a group of 400 presbyopes using the gradient method.[3] In summary form, their results are given in Table 1. The mean value for the ACA ratio is 3.8△ with a standard deviation of ± 2.6△. This value compares very closely to that reported for nonpresbyopic subjects (4.0△ and 3.1△). On the basis of this evidence, the assumption might be made that the ACA does not change significantly with age.

An excellent summary of the above investigations as well as others which have an important bearing on the cause of presbyopia has been made by Alpern. After carefully weighing all the evidence to date, he concluded that it is fairly definite that the ACA ratio does not increase with age.[12]

On the assumption that the ACA ratio is independent of the amplitude, it is possible to predict the effect of multifocal lenses on convergence. As illustrations of some of these effects, Figures 1-3 were prepared. For all of the figures, the near add was computed on the basis that one-half of the amplitude is kept in reserve for a working distance of 40.0 cms. The intermediate add was assumed to be one-half the near add. Also, the distance phoria arbitrarily was set at zero or orthophoria. In the figures, the increase in power of the combination of the eye plus the spectacle lens required for clear vision is plotted as the ordinate while the convergence normally needed for the change of power is indicated as the abscissa. The broken line DB represents the amount of convergence required of an individual with a P.D. of 64 mm., for different distances of fixation.

Add	Number of Subjects
+1.00	5
+1.25	26
+1.50	70
+1.75	135
+2.00	121
+2.25	38
+2.50	5
Total	400

ACA	Number of Subjects
0	6
1	38
2	42
3	75
4	105
5	72
6	50
7	12
Total	400

Table 1. The number of subjects requiring the different adds are given in the table at left. The table to the right gives the number of subjects having the various ACA ratios.

For Figure 1, the ACA ratio is assumed to be 6.0△. With this ratio and through the distance correction, the accommodative con-

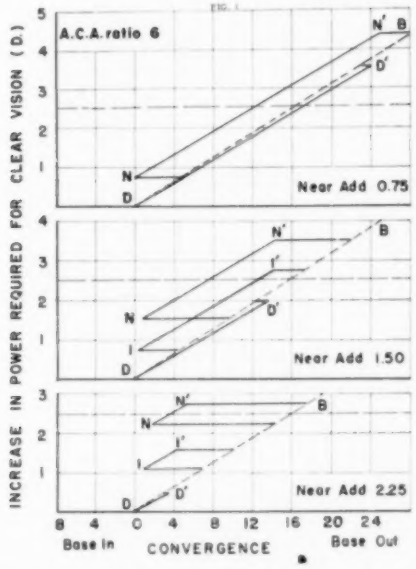

Figure 1. The expected phorias with the prescription of near adds of +0.75, 1.50 and 2.25 D. are given above. The line DB is the convergence required for single binocular vision. The lines DD', II' and NN' represent the expected phoria through the distance, intermediate and near corrections respectively, with an ACA ratio of 6.

vergence almost equals the convergence required for the different distances of fixation. This is shown by the proximity of the line DD' to DB. Through the near and intermediate adds, however, the convergence from accommodative convergence becomes relatively small. In fact, for an amplitude of 0.50 D. the maximum accommodative convergence for any distance of fixation can be only 3△ (Figure 1c).

In the figures, the lines DD', NN', and II' indicate the expected phoria positions through the distance correction and the near and intermediate adds respectively. The horizontal distance between NN' and DB is a measure of the fusional convergence that would be required to supplement the accommodative convergence through the near add.

Similar curves to those presented in Figure 1 are provided for different ACA ratios in Figures 2 and 3. In all the curves of Figures 1-3, the proximal convergence was assumed to be 2△ at 40 cms. For other distances, it would be considered proportional to the distance of fixation measured in diopters.

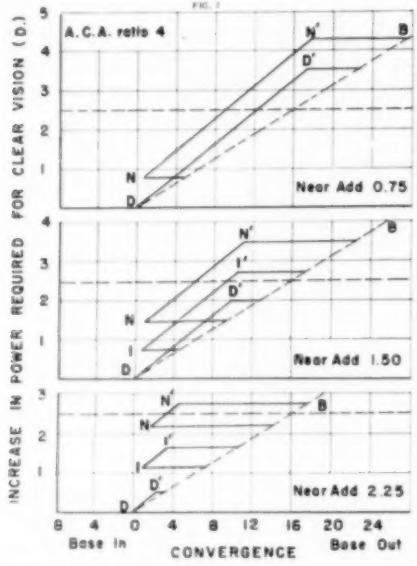

Figure 2. This figure is the same as Figure 1, except that the ACA ratio is 4.0.

A number of interesting facts emerge from a study of Figures 1-3. Perhaps the most striking is that a person with a high ACA ratio will have the greatest adjustment in convergence to make to multifocal lenses. Such an individual will have to supplant fusional convergence for accommodative convergence. Only if the positive fusional reserve is ample, can such an adjustment be made without discomfort.

Another interesting observation is that a lens with both near and intermediate adds conveniently might be used by a person with a high ACA ratio even though the near add is only 1.25-1.50 D.* The graph in Figure 1b illustrates such a condition. Here, it is seen that the expected phoria through the intermediate add is roughly one-half of that expected through the near add. Thus, if one anticipates fusional difficulty due to a low positive fusional reserve in a presbyopic patient, it is desirable to prescribe a trifocal lens with an intermediate field of at least 8 mm. With such a lens, the patient can use either the intermediate or

*The relation of the ranges of clear and comfortable vision through multifocal lenses of different powers has been analyzed and the results presented in a previous paper. One of the conclusions reached as a result of this study was that trifocal lenses are indicated whenever the near addition is +1.25 D. or more.[8]

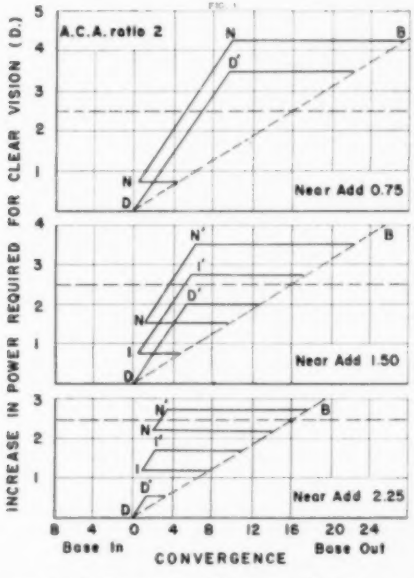

Figure 3. This figure also is the same as Figure 1, with the exception of the ACA ratio. For this figure the ACA ratio was 2.0. It should be noted that with this ratio, there is very little difference between the expected phorias with and without the near additions.

near add for seeing at near working distances and choose that one which is found most comfortable.**

Another method of handling the patient requiring an add with a high ACA ratio is the prescription of a bifocal with the segment decentered nasally, considerably more than the normal inset. By this means base-in prismatic effect can be obtained from the segments. If bifocals of regular size are decentered in this manner, considerable temporal limitation of fields of view through the segments are invariably encountered. To overcome this difficulty, the bifocal with the large segment illustrated in Figure 4 has been designed. With such a bifocal, as much as 1.2△ base-in prismatic effect can be obtained.

In presenting Figures 1-3, no mention was made of the effect of the distance phoria upon the various curves which were illustrated.

**Dr. J. F. Simercek, St. Paul, Minnesota, has used this basis for the prescription of 8 mm. trifocals in adds of +1.25 to +1.75 D. for approximately four years. He claims to have adequate clinical proof to substantiate the procedure.

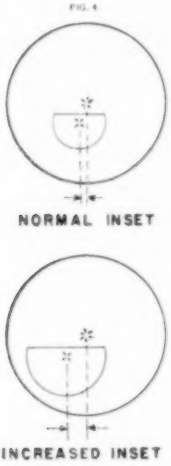

Figure 4. The difference between a bifocal with a normal inset and one with a considerable nasal inset as illustrated. With this design, it is possible to provide base-in prismatic effect in the segment without loss of any temporal field of view.

That it would have a marked effect is without question. In fact, an equation can be derived from which the near phoria can be predicted on the basis of the distance phoria as well as other factors which are involved. If AB and CD represent the interpupillary distance and distance of fixation respectively, in cms., the near phoria is given by:

$$\text{Near Phoria} = \left[100 \frac{AB}{CD} + \text{Phoria @ 6M.} \right] - \left| \text{Diopters of Accommodation (ACA ratio)} + \text{Proximal Convergence} \right|$$

In this equation exophoria is considered plus and esophoria minus. By the relation, it is seen that a patient with a high exophoria and with a high ACA ratio probably would encounter difficulty due to insufficient positive fusional reserve. On the other hand, a patient with esophoria and a high ACA ratio would have more comfort with multifocal lenses than without.

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ANNOUNCEMENTS

NATIONAL BOARD OF EXAMINERS IN OPTOMETRY

The National Board of Examiners in Optometry, as a result of its meeting last December in New York City, makes the following announcements on policies governing examinations, publicity, fees, etc.:

The first examinations will be held next June at accredited schools and colleges of optometry. Dates will be announced.

The first examinations will definitely include Part I, with the probability that Parts II and III will be added the following year. The registration fee will be $10.00 and the examination fee for each Part will be $15.00. Hence the students taking Part I will have a total initial fee of $25.00.

Part I will be available to students in the accredited schools and colleges who will have completed the fourth year of the standard five-year curriculum after 1951, or who will have graduated after 1951. In other words, Part I will be available to students now in their fourth and fifth year of optometry. Parts II and III, when offered, will be available only to graduates who have completed Part I.

Part I will relate to non-clinical and non-professional courses in the optometry curriculum. A more detailed definition of material to be covered will be announced at a later date. It is planned that Part II will relate to clinical and professional courses in the curriculum, and that Part III will be a practical and demonstrational examination of clinical and professional skill.

It was adopted as a procedural policy that the National Board will release no information concerning a candidate's registration, application information, or performance in examination except upon the candidate's authorization. All information obtained from or concerning the applicant, including the fact that he applied or took the examination, will be held confidential except upon his request for release to persons or agencies authorized by him.

A similar policy was adopted in relation to releasing information on individual state boards accepting National Board results. The National Board will not release information indicating which states do or do not adopt the National Board Examinations in lieu of their own. Inquirers will be advised to seek this information directly from the State Board in question. This policy will not preclude, however, periodic or continuous surveys to establish the prevalence of acceptance for general professional information.

As of the date of the meeting five state boards had voluntarily indicated their intention to use the National Board Examinations in lieu of part or all of their own examinations. A formal survey of prevalence of acceptance will not be made until after the first year of operation.

A STUDY OF RETINAL CORRESPONDENCE BY AFTER-IMAGE METHODS*

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INTRODUCTION

The literature contains numerous discussions on the subject of anomalous retinal correspondence and its associated projection. The ambiguity of the above relationship has complicated the approach to the problem of strabismus and amblyopia. A better understanding of anomalous retinal correspondence would introduce new channels of thought and give greater impetus to the study of strabismus and amblyopia.

Determination of retinal correspondence by the use of the after-image was first reported by Hering.[1] Bielschowsky[2] is of the opinion that there is no better way to demonstrate the sensorial relationship of the two eyes than by means of after-images. The relative position of the eyes cannot influence the location of the after-images as long as normal retinal correspondence is functioning. After stimulation one or both eyes may be displaced with the finger or with forceps, yet the figure formed by the after-images will remain unchanged. However, he does say that in some cases the after-image test may be repeated several times in succession under identical conditions and show different types of anomalous retinal correspondence, the centers of the after-images sometimes being twice as far apart as at other times. Bielschowsky further states that the results obtained during the last 40 years in the investigation of the visual act in squint, particularly by means of the after-image test, have compelled observers to acknowledge that retinal correspondence is based on pre-established, innate conditions.

Another viewpoint is expressed by Scobee[3] who asserts that retinal correspondence is not an anatomic peculiarity, innate and unchangeable. In heterotropia anomalous correspondence frequently develops. In this condition an eccentric point of the retina of the deviating eye acquires a more or less perfect correspondence with a point of the non-deviating eye.

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When the visual axes are no longer parallel as the result of a functional disturbance, accident or disease, the visual fields of the two maculae do not coincide. Hartridge[4] states that as a consequence of this incongruity a "false macula" capable of definite fixation frequently develops in the deviated eye. He further maintains that the visual acuity of the region of the retina occupied by the "false macula" rapidly improves until it is far superior to that of the corresponding part of the retina of a normal eye. However, clinical observation does not substantiate this contention.

Adler and Jackson[5] give the following classification of anomalous correspondence.

1. The fixing macula is associated with that part of the retina of the squinting eye on which the image customarily falls, and the projection of these two images in space is the same—harmonious.
2. The macula of the fixing eye is associated with a point on the retina of the squinting eye between its macula and the point where the image customarily falls—unharmonious.
3. A state without functional correspondence, since suppression of that area of the squinting eye on which the image habitually falls is so widespread that no particular area of it is found to correspond directionally with the fixing macula. This condition differs from the other types only in the amount of suppression.

Duke-Elder[6] states that each point on one retina is functionally, although not anatomically, related to a corresponding point on the other. This is primarily an innate and inherited characteristic, but to attain its full value it must be reinforced by experience. In those cases where the eccentricity of projection becomes equal to the angle of strabismus, binocular projection may again become correct in spite of the deviation of the squinting eye.

Verhoeff[7] is of the opinion that practically all concomitant strabismics have anomalous projection. In these cases there is an absence of retinal correspondence of any type and this is contrary to the general belief that abnormal retinal correspondence is present. To give support to the hypothesis, Verhoeff elicited the phi phenomenon in 13 concomitant squinters. Each strabismic fixated one target with one eye, and the other target was so placed that its image occupied the fovea of the other eye. Screens were positioned so as to exclude the extra foveal images of the targets. The extent of the apparent movement closely corresponded to the actual distance between the targets.

In testing with after-images the experimenter must note very carefully and accurately the position of the light reflex on the cornea of the

subject, allow for angle kappa and then determine if fixation was foveal or eccentric. This information is vital in the correct interpretation of the findings. The following illustration will emphasize the importance of this observation.

In a case of eccentric fixation of the left eye under monocular and binocular conditions, Guibor[8] explains that abnormal correspondence is present because a space existed between the two after-images instead of a cross being demonstrated. In view of the fact that eccentric fixation was present, the right eye being stimulated foveally and the left eye offfoveally, obviously a separation of the vertical and horizontal components of the after-image could be expected, thus providing evidence that normal retinal correspondence was present.

In contrast to the above, Stutterheim[9] claims that even when there is a strongly developed "pseudo-fovea," in monocular vision the eye always uses the true fovea. The question immediately arises whether foveal fixation is possible under monocular conditions if a large central scotoma is present.

In the extensive work of Burian[10] several methods were invariably used to determine the sensorial retinal relationship. The tests consisted of the synoptophore (cover test), the double image and the after-image. By the use of the double image test, Burian showed that in most cases of anomalous correspondence the fovea of one retina and an eccentric element of the other acquire a common visual direction.

Interpreting this relationship, Kramer[11] states that the adapted strabismic (having developed anomalous retinal correspondence) experiences fusion instead of diplopia when fixating an object directly ahead. The image located on the fovea of the fixating eye and a peripheral retinal element of the deviating eye is fused since the two normally noncorresponding retinal elements now have the same visual direction and localization in space. By acquiring the same visual direction, they have become corresponding retinal elements.

It is evident from the foregoing discussion that opinion varies widely as to the relationship existing between the two eyes in abnormal retinal correspondence. However, the trend strongly favors the concept that the fovea of the fixating eye and an extramacular element of the deviated eye have a common visual direction which of course implies single vision with these two originally disparate retinal elements. Now, if the preponderance of information found in the literature is correct and since Burian[12] states that this relationship has been shown to exist by the use of the double image test, it follows that if the fovea of one

retina and an eccentric element of the other acquire a common visual direction, it should also be demonstrable on the after-image test.

HYPOTHESIS

Two different methods of taking after-images are frequently used for the determination of retinal correspondence.

The procedure introduced by Bielschowsky is a technique which may be applied quite easily. A lamp with a straight filament is mounted on a solid base in such a way that it may be pivoted around its central point of attachment and placed either in the horizontal or in the vertical position. The central part of the filament is concealed by a metal ring on which is painted a red circle that serves as a fixation mark. The observer is seated so that the fixation mark is at eye level and at a distance of one-half meter. The test is taken monocularly; therefore one eye is covered by an occluder while the other eye is looking directly at the fixation mark with the filament in the vertical position. Then this eye is covered and the opposite eye fixates the filament in the horizontal position. The time of exposure is 20 seconds for each eye.

During the exposure a strong light stimulus reaches the principal vertical meridian of one eye and the principal horizontal meridian of the other eye. In neither eye is the fovea stimulated because of the presence of the opaque fixation spot and surrounding black metal band. The two successively produced after-images are now seen simultaneously, as positive after-images in a darkened room and as negative after-images in a lighted room. The non-stimulated foveas will appear as a gap in the streaks. If the two lines bisect to form a cross with a "hole" in the center, the correspondence is assumed to be normal. If the retinal correspondence is not normal, one of the lines of the after-image will appear shifted laterally.

Koehler and Wallach[13] showed that extended time exposures of figures presented to one eye may affect the visual sensations of the other eye. Brock[14] developed the after-image transfer on this basis.

In this method, as described by Brock,[14] the observer is seated approximately four feet from the after-image tester, the filament of which is retained upright and stationary throughout the test. A pinpoint opening in the center of the metal band serves as a fixation point.

The dominant eye is exposed to the luminous vertical filament for 20 seconds while the deviating or amblyopic eye remains totally occluded. After the exposure and without removing the occluder, the observer shifts his gaze to the center dot of a test chart. The subject then reports the position of the after-image in relation to the central dot while steady fixation is maintained on this point. If foveal fixation is present,

the after-image will be reported as a broken vertical streak with the dot situated in the center of the broken area. This serves as a preliminary check to assure:

1. Ability to maintain direct fixation with the dominant eye.
2. Ability to identify and designate the position of an after-image correctly.

The above procedure is repeated except that upon completion of the second exposure the occluder is switched to the dominant eye and the observer attempts to maintain fixation of the black central dot of the test chart with the deviating eye. The test chart is marked off in degrees and the relative position of the streak is reported. The significance of the test is based on the following:

1. By the initial test it is shown that the after-image formed a straight line through the fixation point of the dominant eye, that is, it was centered with regard to the frame of reference. Therefore, the perceptual center may be assumed to be in the exact center of the anatomical fovea.

2. If the streak is perceptually transferred to the other eye, it must be transferred to a perceptually corresponding area, and projection must coincide with the same frame of reference.

3. If the squinting eye maintains direct fixation on the central dot of the test chart, the perceived after-image should appear directly above and below this dot. However, if the strabismic eye is turned slightly off center, the after-image must be displaced an equal amount and in the same direction.

Thus, the test indicates whether the deviating or amblyopic eye projects to the fixation point of the frame of reference. If the perceptual center is measurably out of agreement with the anatomical center of the eye, anomalous retinal correspondence is present. If the perceptual center is projected through the fovea of an amblyopic eye which has lost central fixation, or has become perceptually blind along this center axis due to an absolute central scotoma, it means that the correspondence remains unchanged.

At the present time many assumptions and theories have been advanced regarding anomalous retinal correspondence and its associated projection, but the evidence is not sufficient to substantiate any of the claims to the exclusion of others.

In the literature abnormal retinal correspondence is said to exist when elements of the two retinae which are ordinarily disparate, such as the fovea of one eye and an eccentric element of the other eye, acquire a common visual direction. Another definition—that an extramacular

element of the deviating eye adopts the visual direction of a disparate point, namely that of the fovea of the fixating eye. Some authors have stated that fusion occurs when the fovea of the fixating eye and the peripheral retinal elements of the squinting eye on which the image customarily falls are stimulated.

The purpose of this investigation is to verify by the use of after-images, the accuracy of present concepts regarding retinal correspondence.

To accomplish this objective a vertical light filament will be exposed to one eye and a horizontal filament to the other eye simultaneously and under binocular seeing conditions. Thus, the principal meridian of the dominant eye will be stimulated and at the same time the peripheral retinal area of the deviating eye normally stimulated under casual seeing conditions will be exposed to the light stimulus. Now, if the fovea of the dominant eye corresponds to this extramacular element (anomalous retinal correspondence), the observer should report a cross; if there is no correspondence of these areas, a lateral separation of the components of the after-image should be observed.

In this procedure a central scotoma will not interfere with the results since in the deviating or amblyopic eye only the peripheral area which normally receives images from objects which are straight ahead in environmental seeing conditions will be exposed to the stimulation. By this simultaneous exposure method an approach to casual seeing is attained.

OBSERVERS

Twelve observers, taken from the Chicago Strabismic Project, were used in conducting this investigation. Of this number, seven were divergent and five convergent strabismics.

Sex, age and previous attempts at correcting the visual anomaly by the use of prisms, lenses and other visual training procedures, although recorded, required no separate classification or analysis.

APPARATUS

In designing the equipment for this investigation, it was necessary to satisfy several requirements.

1. Binocular arrangement—both eyes must be stimulated simultaneously.

2. Brightness—ample to give adequate after-image when peripheral retinal elements were stimulated. This eliminated the use of polaroid or anaglyph filters due to the difficulty in obtaining pure filters —and of paramount importance, both of these materials reduced the brightness to a level where it was difficult to obtain an after-image.

3. Position of head—the head must be held in a stationary position during the exposure.

4. Measurement of deviation—a fixation chart marked off in degrees for the purpose of determining the extent of the deviations.

The apparatus which was constructed to satisfy these requirements consisted of four main parts, namely, the viewing instrument, headrest, after-image lamps and fixation chart.

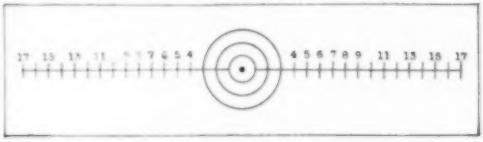

Figure 1

FIXATION CHART

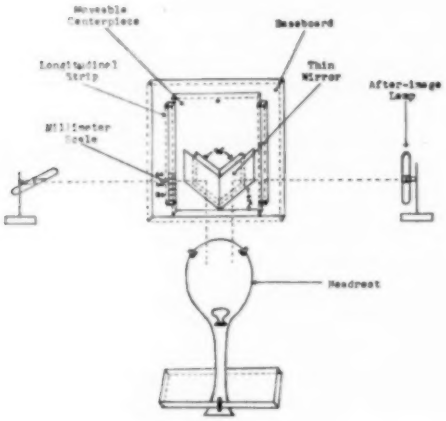

Figure 2

EXPERIMENTAL APPARATUS

The viewing instrument (Figure 2) consisted of a baseboard 45 cm. by 35 cm. on which were mounted two longitudinal strips which served as guides for a moveable centerpiece. Two mirrors each 17.5 cm. square and inclined at an angle of 90° to each other were attached to the centerpiece. The mirrors were centered at a height of 102.5 cm. above the floor. A millimeter scale was attached to the left longitudinal strip, permitting adjustment for varying pupillary distances.

A headrest was used so that the centers of the pupils were exactly 102.5 cm. from the floor. In this position, with the scale set at 60

millimeters, the anterior portion of the corneas were approximately 8.75 cm. from the imaged fixation dots in the mirrors.

Two after-image lamps were used simultaneously. They were mounted on a solid base and illumination was attained by General Electric clear bulbs (No. 40T8). The central part of the filament was concealed by a black metal band 12.5 mm. wide on which was a small red circle 4.5 mm in diameter which served as a fixation mark. One after-image lamp was placed in a vertical and the other in a horizontal position at a distance of 36.25 cm. from either mirror. The center of fixation points was exactly 102.5 cm. above the floor and made an angle of 45° with each mirror.

The after-image was projected upon a fixation chart (Figure 1) placed at a distance of 1.83 meters from the observer. The chart consisted of a broken horizontal line marked off into equal sections of 31.25 mm. in width. A solid central circle 6.25 mm. in diameter served as the fixation point. With this dot as a center, three concentric circles were thinly drawn with radii of 1°, 2°, 3°. In addition to measuring lateral deviations, the circles also measured vertical variations. The marked-off sections of the horizontal lines were numbered to show the lateral decentration in degrees from the central fixation point.

In the Bielschowsky Method vertically and horizontally positioned after-image lamps were used. In the Transfer Method only the vertical filament was necessary. In both of the above procedures the fixation chart was necessary for measuring lateral and vertical deviations.

PROCEDURE

The procedure was divided into two general divisions as follows: 1. Preliminary data and tests. 2. The after-image tests.

The information compiled under item one was taken in sequence and tabulated according to the following headings:

Identification—Name and type of strabismus.

Sex and age.

Acuity—With and without prescription. O.D., O.S. and O.U.

Angle Kappa—Measurement of the angle.

Angle of squint and type of diplopia.

Troposcope—Measurement of objective and subjective angle.

Prism cover test—Measurement of objective angle.

Double image test—Determination of type of diplopia.

Tangent cross—Measurement of objective and subjective angle and determination of type of diplopia.

The second part consisted of the following after-image tests which were exposed in a random sequence to each observer:

Experimental Method.
Bielschowsky Method.
Transfer Method.

During the entire procedure in each method the room was dimly illuminated by a 15-watt frosted bulb which was covered with a translucent shade. A floodlight switched on and off was used as an aid in producing awareness of the after-image.

In the Experimental Method the observer wore his correction if it was habitually used for distance. To eliminate the possibility of accommodation due to awareness of nearness, and thus a change in the angle of squint, plus 2.25 D. lenses were worn. The observer was seated comfortably in front of the viewing instrument. The mirrors were set according to the previously measured pupillary distance. The headrest permitted exact alignment of the eyes. The non-squinting eye always fixated the mirrored image of the red dot of the horizontal filament. The squinting eye in its habitual position in relation to the dominant eye received the stimulus from the vertical filament upon that portion of the retina normally stimulated under casual seeing conditions. Both lamps were illuminated simultaneously, fixation being maintained for 20 seconds.

After the exposure the observer moved to a position which had been marked 1.8 meters from the fixation chart. Now, while holding a steady fixation on the central dot, the subject was asked if the horizontal "streak" was aligned with the horizontal line of the chart. If the answer was in the affirmative, he was then asked if the fixation dot was located centrally in the gap of the horizontal streak. This response was absolutely essential before proceeding. When this was achieved the observer was handed a 1.5 meter pointer and told to point to the vertical streak. Deviations in the vertical, horizontal or both components of the after-image were then recorded.

Augmenting the above procedure additional observations by the use of the Experimental Apparatus were made on all subjects. By moving longitudinally the vertical after-image lamp, which was always placed before the deviating eye, the light reflex could be placed centrally or on various temporal or nasal portions of the cornea thus stimulating different areas of the retina.

The purpose of this procedure was to attempt to demonstrate corresponding areas or common visual directions in those cases showing anomalous retinal correspondence by the preliminary tests.

Examination of cases showing normal correspondence by this method was for comparison.

In the Bielschowsky Method two separate lamps were used. The observer was seated on a pivoting chair 45 cm. from the horizontal filament with fixation being maintained on the red central spot situated at eye level. The squinting eye was covered by an occluder during the 20-second exposure. Then the non-squinting eye was covered while the subject rotated the chair for alignment with the vertical filament. Fixation was maintained on the red dot and the exposure was again for 20 seconds. Deviations of the vertical, horizontal or both components of the after-image were measured on the fixation chart in the identical manner described previously.

In the Transfer Method only the vertical filament was used before the non-deviating eye. The observer, seated at a distance of 45 cm. was conditioned by an exposure of 10 seconds, the squinting eye being covered. With the occluder held in position the subject at a distance of 1.8 meters fixates the central dot of the chart. If he reported the after-image of the light filament as a broken vertical streak with the dot situated at the center of the broken area, the test was continued. The second exposure was identical to the first but this time for 20 seconds. Now the occluder was switched from the squinting eye to the dominant eye and fixation was directed to the central dot of the chart. Beyond this point the procedure was the same as for the previous two methods.

Each procedure was repeated a minimum of two times on each observer.

RESULTS

The reliability of the instrumentation was insured by the test re-test method on a very critical subject who possessed good single binocular vision. The findings obtained were highly consistent. Similar data were obtained on retesting the observers used in the investigation.

The maturity of the subjects provided dependable responses since all were between the ages of 18 and 38 with the exception of one.

Angle kappa was measured carefully on all observers, as this angle determined the location of the light reflex on the cornea to achieve foveal stimulation.

The angle of squint and type of diplopia were measured by the various methods previously listed. Thus pertinent information was provided as to which type of retinal correspondence was present as well as the degree of adaptation. Of the 12 strabismic subjects four were fully adapted exotropes, that is, anomalous retinal correspondence was demonstrated on all the preliminary tests, two were partially adapted, and six showed normal retinal correspondence on all entrance tests.

By use of the Experimental Apparatus findings were taken under

conditions which simulated environmental situations, i.e., the stimulation from the after-image lamps fell upon each retina as the stimulus would form an object of regard under casual seeing conditions. Under this arrangement the gaps in the vertical and horizontal components of the after-image were in no case located at the central dot of the fixation chart. *Thus a cross was not demonstrated.* This is significant in view of the fact that four of the observers were well-adapted exotropes, i.e., the anomalous retinal correspondence was deep-seated. Since the fully adapted strabismics were left exotropes the stimulation which simulated casual seeing conditions fell upon the far temporal portion of the retina of the left eye, yet was projected to the left. A second stimulation to the temporal retina, moving in the direction of the fovea, resulted in projection still farther to the left. Of course, stimuli to the nasal retina produced an after-image which was projected far to the left. It now became evident that under binocular conditions regardless of the portion of the retina stimulated, projection from the left eye was always to the left, only the extent or degree being dependent upon whether the nasal or temporal portion was stimulated.

Further explorations were made by having the normally deviating left eye function as the fixating eye, thus the dominant right eye was stimulated with the vertical filament. The response was identical to the above with the exception that projection was always to the right regardless of the retinal area stimulated. Even though the attention of the observer was called to the fact that the images of the unlighted filaments were in a crossed position upon alternate fixation when looking into the mirrors, the after-images were reported as uncrossed. This paradoxical situation was always confusing to the subject, but always the same consistent response of homonymous projection was obtained. When questioned, the usual reply was that the horizontal and vertical streaks of the after-image should have been reversed.

Those observers showing normal retinal correspondence and others indicating some degree of adaptation invariably reported a crossed relation of the after-images on stimulating the temporal retina and an uncrossed relation on stimulating the nasal retina. By allowing for angle kappa and thus stimulating the exact principal vertical meridian a cross could be elicited by the Experimental Method on those subjects possessing normal retinal correspondence. This was of particular interest in the case of the strabismic amblyope where evidence of a central scotoma was present and yet the after-image cross was obtained: whereas by the other methods this observer showed deviations from 0° due to an eccentric fixation as a result of the central defect. Based on the laws of pro-

jection used in physiological diplopia the above results are readily understandable.

However, in the fully adapted exotropic strabismics the projection was homonymous (in varying degree) *regardless of whether the nasal or temporal retina was stimulated.* Frequent retests showed the same consistent results.

The results of the Bielschowsky Method indicated that four of the observers were fully adapted strabismics. This is shown since the separation of the vertical and horizontal components of the after-image measure directly the angle of anomaly. In view of the fact that this angle was approximately the same as the angle of squint measured by various instrumentations, these subjects were fully adapted and the abnormal retinal correspondence considered to be harmonious.

If eccentric fixation was observed the presence of a central scotoma was indicated and the deviation of the vertical streak of the after-image from the 0° merely confirmed the observation and served as a measure of the off-central fixation: it did not indicate anomalous retinal correspondence. If the fixation was unsteady, numerous vertical streaks were reported in the after-image. Two of the subjects had previously undergone surgery, with the responses indicating that a transition point had been reached between anomalous and normal retinal correspondence.

In the Transfer Method the four fully adapted strabismics were unable to elicit a "transfer" of the after-image, indicating the absence of a binocular percept. It was of interest to note that these subjects were aware of an after-image from the eye which had been stimulated and was then covered: the after-image was reported on the paddle occluder.

Normal retinal correspondence was invariably present when the gap in the vertical streak was located at the fixation dot. However, where evidence indicated that a central scotoma was present, the perceived after-image was displaced by the amount of the eccentric fixation. A shifting after-image indicated that the fixation was unsteady.

CONCLUSIONS

Five main conclusions can be drawn from the results of this investigation.

1. The test for reliability showed the instrumentation to be satisfactory for the purposes of the experiment.

2. Under the conditions of the experiment common visual directions could not be demonstrated in divergent strabismics who showed anomalous retinal correspondence and who were well adapted to the angle of squint, the projection being homonymous regardless of retinal area stimulated.

3. Normal and anomalous retinal correspondence are identifiable by the Experimental, Bielschowsky and Transfer Methods of taking after-images.

4. In the Bielschowsky and Transfer Methods of taking after-images deviations of the vertical streak from 0° may be caused by an off-foveal fixation frequently resulting from a central scotoma, or unsteady fixation.

5. A measurement in degrees of the off-foveal fixation may be accomplished by the use of after-images.

In view of the fact that no convergent strabismics showing anomalous retinal correspondence and being fully adapted to the angle of squint were used in this experiment, it is suggested that further investigation be pursued in this direction.

SUMMARY

The literature is replete with discussions of anomalous retinal correspondence. Many theories have been advanced in an attempt to clarify the problem, but the differences of opinion are numerous and many basic questions are still unanswered.

The purpose of this investigation was to verify through the use of after-images, the accuracy of present concepts regarding retinal correspondence.

In conducting this experiment, a total of 12 observers were used. Of this number, seven were divergent and five convergent strabismics.

The apparatus constructed for the investigation consisted of four main parts, namely, the viewing instrument, headrest, after-image lamps and fixation chart.

The procedure was divided into two main parts:

1. Preliminary data and tests.
2. The after-image tests.

Retesting showed that the technique was reliable.

Under the conditions of the experiment common visual directions could not be demonstrated in divergent strabismics who showed anomalous retinal correspondence and who were well adapted to the angle of squint.

Normal and anomalous retinal correspondence are identifiable by the Experimental, Bielschowsky and Transfer Methods of taking after-images.

A measurement in degrees of the off-foveal fixation may be accomplished by the use of after-images.

EDITORIAL COMMENT: This manuscript is certainly worthy of publication. If the facts presented can be duplicated and enlarged upon by other investigators a significant change in our concept of projection in heterotropic individuals will be necessary.

J. Donald Kratz, Chairman,
Orthoptic Section,
American Academy of Optometry.

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The American Academy of Optometry and the publishers of this journal have no objection to the reprinting by other magazines of any of the articles in this issue, provided such reprints are properly credited to the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.

THE ACADEMY AND THE A. O. A.*

At New York, the Executive Council on behalf of the Academy passed a resolution which will prove to be of great value to the optometric profession. This resolution favors the closest cooperation with the American Optometric Association and obliges all Fellows (save in exceptional cases) to support the A. O. A. by their membership.

The resolution in its preamble states that the A. O. A. is the first line of defense for optometry and that, but for the A. O. A., the profession would suffer irreparable injury. That this is true is well illustrated by the successful fights which the A. O. A. has waged in the interest of optometry. The commissioning of optometrists in the army and the deferment of optometry students are but two of the

*A request guest editorial by Joseph Ziff, O.D., Fellow, American Academy of Optometry, and President, California Optometric Association.

benefits which the Association has gained for optometry. Most recently, representatives succeeded in having optometrists exempt from O. P. S. regulations, and hence treated as a professional group as distinguished from a retailing group.

The passing of this resolution is as far as the Executive Council can go toward cementing relations between the two groups. There is, however, a further consideration with which every Fellow should concern himself, and that is activity in the state, county, and American Optometric Association. Because the standards of the Academy are so high and the requirements so exacting, the Fellows must represent the very best in optometry. The thinking and leadership of these men are needed in Association affairs.

Academy Fellows in conformity with the Executive Council resolution will support the Association by their dues and membership. It is more important, however, that they bring to the Association their ideals, their ideas, and their willingness to serve. Many of the Academy Fellows have held office in county, state, and national associations, and have enriched the profession by their efforts. It now behooves every Fellow to attend Association meetings, to express himself, and when called upon, to serve. An academic and aloof attitude toward the Association will rob optometry's first line of defense, the Association, of the ideas and guidance which Academy members can offer.

JOSEPH ZIFF.

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STUDENT DEFERMENTS—SSS FORM 109 FOR USE IN OPTOMETRY COLLEGES

SSS Form No. 103 dealing with deferment of students in the healing arts colleges which was previously provided for submitting evidence to local draft boards in support of claims for deferment, Class II-s, has now been discontinued. Students in the healing arts colleges will now be reported on by means of the SSS Form No. 109, this being the same form in use for all college deferments. In optometry colleges deferments now in effect which have been made on the basis of information furnished on the SSS Form No. 103 may be continued for the remainder of the periods for which the student has been deferred. The full text of SSS memorandum No. 43 of December 31, 1951, follows:

1. *Eligibility of College Students for Consideration for Deferment.*—Sections 1622.15 and 1622.25 of the Selective Service Regulations now specify in detail the requirements which are necessary in order that registrants who are college students may be eligible for consideration for deferment because they are engaged in study both in

cases of claims for statutory deferment in Class I-S and in cases of claims for deferment in Class II-S because of their activity in study being necessary to the maintenance of the national health, safety, or interest. Within the specified requirements prescribed in these regulations, students of the healing arts are to be considered for deferment in the same manner as students who are pursuing other undergraduate or graduate courses at colleges, universities, or similar institutions of learning.

2. *Furnishing Information to the Local Board.*—(a) The College Qualification Test Score Report (SSS Form No. 108) has been prescribed for use in furnishing to the local board the score attained by a registrant on the College Qualification Test.

(b) The College Student Certificate (SSS Form No. 109), as revised October 30, 1951, has been prescribed for the use of a college, university, or similar institution of learning in furnishing to the local board information regarding the status of the registrant as a student at such institution. Upon request of the registrant his educational institution should submit information of his status as a student in accordance with the instructions on the form. The filing with a local board by an educational institution of a completed SSS Form No. 109 does not constitute a request for the occupational deferment of the registrant. An educational institution or any person must file with the local board a specific written request for the registrant's occupational deferment in order to establish a right of appeal under section 1626.2 of the regulations.

(c) Whenever an educational institution has submitted a College Student Certificate (SSS Form No. 109) for one of its students to a local board, the educational institution will advise the local board if the student at any time thereafter either ceases to pursue his course of instruction in a manner which is satisfactory to the educational institution, or ceases to be a student at the institution.

3. *SSS Form No. 103 Discontinued.*—The use of the Certification of Preprofessional and Professional Students (SSS Form No. 103) previously provided for submitting evidence to the local board in support of claims for deferment of students of the healing arts has been discontinued. Deferments now in effect which have been made on the basis of information furnished on the SSS Form No. 103 may be continued for the remainder of the periods for which the student was deferred. Hereafter, every request for the occupational deferment of a college student must be supported by the submission of a completed SSS Form No. 109, as revised October 30, 1951.

CAREL C. KOCH.

TRANSACTIONS OF THE AMERICAN ACADEMY OF OPTOMETRY

A department devoted to announcements, reports, appointments, organization data, news, professional problems and ideals, as these relate to the Academy.

ANNUAL REPORT OF THE PRESIDENT*

Harold Simmerman†
Woodbury, New Jersey

Greetings and good wishes to all of you on our thirty-first annual meeting of the American Academy of Optometry. It is a pleasure to be with you again at the Academy's business sessions and especially so at its formal scientific and academic presentations.

*Presented at the annual meeting of the American Academy of Optometry, New York, New York, December 8, 1951. For publication in the February, 1952, issue, AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.

†Optometrist, Fellow, American Academy of Optometry, Member of faculty, Pennsylvania State College of Optometry.

May I take this opportunity to thank all of the committees and officers who have so generously and diligently aided in making the forthcoming annual meeting the success that I know it will be. Special mention must go to the papers and program committee who spent practically an entire year in arranging this meeting. Also included among the hard working groups is the committee on admittance, whose work does not start and stop with the cycles of the annual meetings, but whose efforts are continuous. My congratulations go out to the chairmen of the five sections, who by their constructive efforts add a practical, clinical note to our otherwise more formal and research type of papers.

I would like to pay special tribute to our Secretary, Dr. Carel Koch, who in my opinion, is the finest and most efficient secretary any organization could ever hope to have. I have been in constant contact with him and I consider it not only a pleasure but a privilege to work with such a fine fellow. The Academy will be eternally indebted to Dr. Koch for the multitude of contributions that he is making to its welfare and success.

The American Academy of Optometry has had a slow, steady and natural growth and is now in the strongest position in its history. There have been no dramatic and phenomenal increases in membership status, which bespeaks well for its health. Bulbous and inflated membership growth is an undesirable characteristic in any organization and leads to tremendous membership turnover. This is entirely absent in the Academy and because of its strict adherence to professional, scientific and academic principles we can predict a very strong and healthy future for it.

The Academy makes every effort to abstain from and to delegate those matters which by their nature and policy significantly belong to the activities of the American Optometric Association. The Academy takes notice of, and indulges in, activities that are professional and academic in nature, but it feels that the complete support of its weight and influence by its individual members should be in support of the profession's parental body, the American Optometric Association. As evidence of this attitude the American Academy of Optometry went on record in its regular Executive Council session by passing the following resolution:

WHEREAS: The American Optometric Association, with its affiliated State and local associations, constitutes the first line of defense for optometry without which the profession rapidly would suffer irreparable injury if not complete disintegration. Now therefore be it

RESOLVED: That we the members of the American Academy of Optometry in the annual meeting assembled hereby go on record as favoring the closest association

with the American Optometric Association and its affiliated State and local associations, and be it further

RESOLVED: That only under exceptional circumstances should an Academy member actively engaged in practice in the U.S.A. be considered as free from obligation of membership in his local, State, and the American Optometric Association.

Furthermore, the Academy stands ready to lend its full support to any endeavors of the American Optometric Association when the nature of those endeavors fall within the limits and interests of the Academy's contributions to the profession.

The American Academy of Optometry encourages the formation of new chapters, and is vitally interested in the activities within its various chapters. However, so that the records may be kept straight, we wish to repeat that the loyalty of the members in this Academy is first to the Academy itself; secondly to the chapter. Occasionally there are chapters which tend to "over organize" to a point where the parent body is made secondary to the interest of local matters. This tends to put the emphasis on membership in the wrong place. It must be understood that the encouragement of the formation of chapters on the part of the Academy is for two reasons and these two reasons only:

1. To afford a meeting place in local geographical areas of Academy members during the interim between the annual meetings.

2. To encourage, aid and direct efforts to gain new Academy members.

If local chapters have any other reasons for their existence these reasons are purely incidental. True, there must be some local sovereignty given to chapters in making up their constitutions and activities and the Academy recognizes these needs. However, since it is of real concern to the Academy, the Executive Council re-emphasizes its requirements that the local chapter constitutions be patterned after and conform to the constitution of the American Academy of Optometry. If this were followed out there would be very few "local chapter problems."

It is common knowledge that the American Academy of Optometry is made up of two classes of members. The first group are the educators, the researchers, the scientists and the academicians. To this group we need give no inspiration and re-affirmation of Academy's policy concerning scientific learning. The Academy was organized for and stands for the highest and most fundamental of all learning in the visual sciences. To show evidence of this interest it makes grants-in-aid annually to the various colleges and universities teaching optometry. This program it follows diligently within the scope of its financial ability. In recent years the Academy has become affiliated with the American Association for the Advancement of Science. This year through this affiliation the opportunity to participate in Federal grants-

in-aids for graduate scientific study has been afforded optometry. It is evident, therefore, that the Academy's program for aiding and assisting problems in research will go on as it always has been, inspired by its many educators to newer and greater achievements in the field of vision.

The second group that forms by far the bulk of the membership of the Academy are the practitioners whom we can consider for the moment as the members who function at the clinical level. It is to this group that the Academy owes most of its strength and high esteem. It is this group that puts into practical application in their offices those principles and precepts discovered and formulated by the educators. It is to this group of clinicians that the Academy would like to reiterate and revive the principles that make the Academy so strong.

1. In the doctor-patient relationship the Academy as well as the code of practice of the A. O. A. stands for exhaustive investigation of symtomatology in the interest of the patient's welfare, when may we say under some circumstances, the natural inclination would be to give up. The practitioner with Academy principles never ceases until his patient's interests and welfare are completely served. This repeated over and over again hundreds of times, at the office level, gives strength to the Academy.

2. The Academy stands for the highest in professional relationship and feels that public welfare can best be served only when this state of affairs exists. Therefore, the Academy and the code of practice of the A. O. A. with a fine sense of inter-professional responsibility and with cognizance of all the delicate human whims that are incidental to such relationships, recommends that inter-professional dealings be practiced with the greatest of care so that again the patient's interests and needs are fully served. This, too, repeated hundreds of times at the clinical level, is the source of strength of the Academy.

3. The Academy feels that consultation within its own profession among its colleagues is often essential for patient's interests and encourages any necessary frequency of such consultations. Repeated many times again adds strength to the Academy.

To emphasize: this combination of members at the research level together with members at the clinical level and all members standing for the highest academic and professional aims makes a very strong cooperative combination. Your Academy stands with enviable esteem and prestige.

It is hoped that the re-affirmation of these principles and policies is an inspiration to its members, and that the body politic feels confident that the leadership is directing the administration and guidance of the Academy in the direction that you desire.

ACADEMY COMMITTEE APPOINTMENTS FOR 1952

Dr. Harold Simmerman, president, announces the following committee appointments for 1952:

COMMITTEE ON ADMITTANCE

Dr. Arthur P. Wheelock, Des Moines, Iowa, general chairman.

Region 1. Dr. O. L. McCulloch, Holyoke, Massachusetts, chairman; Dr. William G. Walton, Jr., Merion, Pennsylvania; Dr. Bernard A. Baer, Washington, D. C.

Region 2. Dr. Arthur Kitchen, Clearwater, Florida, chairman; Dr. Donald A. Springer, Anniston, Alabama; Dr. J. T. Campbell, Washington, North Carolina.

Region 3. Dr. E. E. Reese, Westerville, Ohio, chairman; Dr. I. M. Borish, Kokomo, Indiana; Dr. Rudolph Ehrenberg, Granite Falls, Minnesota.

Region 4. Dr. Otto J. Bebber, Denver, Colorado, chairman; Dr. J. Wolff, Spokane, Washington; Dr. Monroe J. Hirsch, Los Angeles, California.

ADVISORY COUNCIL

Dr. D. G. Hummel, Cleveland, Ohio, chairman. Dr. Harold Fisher, New York City; Dr. J. Fred Andreae, Baltimore, Maryland; Dr. Walter I. Brown, New Bedford, Massachusetts; Dr. Richard M. Hall, Cleveland, Ohio; Dr. Carel C. Koch, Minneapolis, Minnesota; Dr. Don R. Paine, Topeka, Kansas; Dr. M. Steinfeld, Paducah, Kentucky; Dr. Arthur P. Wheelock, Des Moines, Iowa; Dr. Eugene Wiseman, Buffalo, New York.

EDITORIAL COUNCIL

Dr. Harold Fisher, New York City, chairman. Dr. Carel C. Koch, Minneapolis, Minnesota; Dr. Robert E. Bannon, Southbridge, Massachusetts; Dr. I. M. Borish, Kokomo, Indiana; Dr. V. J. Ellerbrock, Columbus, Ohio; Dr. Rudolph Ehrenberg, Granite Falls, Minnesota; Dr. Richard Feinberg, Chicago, Illinois; Dr. Eugene Freeman, Chicago, Illinois; Dr. Glenn Fry, Columbus, Ohio; Dr. Henry W. Hofstetter, Los Angeles, California; Dr. D. G. Hummel, Cleveland, Ohio; Dr. J. Donald Kratz, Souderton, Pennsylvania; Dr. Leo F. Madigan, Boston, Massachusetts; Dr. Meredith W. Morgan, Jr., Berkeley, California; Dr. John C. Neill, Philadelphia, Pennsylvania; Dr. Harold Simmerman, Woodbury, New Jersey; Dr. William O. Vivian, Media, Pennsylvania; Dr. Gordon L. Walls, Berkeley, California.

COMMITTEE ON STUDENT COUNSEL

Dr. R. W. Tubesing, Richmond, Indiana, chairman. Dr. Mathew Alpern, Forest Grove, Oregon; Dr. V. J. Ellerbrock, Columbus, Ohio; Dr. Richard Feinberg, Chicago, Illinois; Dr. H. W. Hofstetter, Los Angeles, California; Dr. George W. Keevil, Toronto, Ontario, Canada; Dr. Harold Fisher, New York City; Dr. Eugene Freeman, Chicago, Illinois; Dr. C. H. Pheiffer, Memphis, Tennessee; Dr. O. L. McCulloch, Holyoke, Massachusetts; Dr. Meredith W. Morgan, Jr., Berkeley, California; Dr. Julius Neumueller, Haddonfield, New Jersey; Dr. Martin Snook, Newton, New Jersey.

PAPERS AND PROGRAM COMMITTEE

The following men have been appointed to serve on the papers and program committee. Chairmen of the Academy sections will serve on this committee as ex officio members. Dr. Meredith W. Morgan, Jr., Berkeley, California, chairman. Dr. I. M. Borish, Kokomo, Indiana; Dr. Isidore Finkelstein, New York City; Dr. Henry W. Hofstetter, Los Angeles, California; Dr. F. W. Sinn, Philadelphia, Pennsylvania.

SECTION APPOINTMENTS

SECTION ON ORTHOPTICS

Dr. J. Donald Kratz, Souderton, Pennsylvania, chairman. Dr. Daniel Woolf, New York City; Dr. S. Winfield Smith, Wilmington, Delaware; Dr. Milton N. Chodroff, New York City; Dr. Arthur Jampolsky, San Francisco, California; Dr. Wilma Baber, Los Angeles, California; Dr. J. I. Pascal, New York City.

SECTION ON PATHOLOGY

Dr. William O. Vivian, Media, Pennsylvania, chairman. Dr. Z. J. Schoen, Chicago, Illinois: Dr. I. Irving Vics, Albany, New York: Dr. Henry L. Wolfe, Marshalltown, Iowa.

SECTION ON CONTACT LENSES AND CONTACT LENS EXAMINING BOARD

Dr. John C. Neill, Philadelphia, Pennsylvania, chairman. Dr. Irving P. Filderman, Memphis, Tennessee: Dr. Isidore Finkelstein, New York City: Dr. V. J. Ellerbrock, Columbus, Ohio: Dr. Meredith W. Morgan, Jr., Berkeley, California.

SECTION ON ANISEIKONIA

Dr. Leo F. Madigan, Boston, Massachusettts, chairman. Dr. V. J. Ellerbrock, Columbus, Ohio: Dr. Bernard Mazow, Houston, Texas: Dr. Oscar L. McCulloch, Holyoke, Massachusetts: Dr. Kenneth B. Stoddard, Berkeley, California.

CURRENT COMMENTS

Virginia Huck
Editorial Assistant

Optometrists will confer a favor by sending news items of general interest for this department: such as relate to new instruments, clinical techniques, education, visual health and optometric legislation and organization.

THE MAIL MUST GO THROUGH

Last Fall, Dean E. J. Fisher of the College of Optometry of Ontario promised us a story of his school to add to our survey of college activities across the country. When his report hadn't arrived at press time in December, we thought that probably the Christmas rush had overtaken Dr. Fisher, but such was not the case. Yesterday [Jan. 25.] the mailman delivered a battered, smoke smudged, water soaked envelope marked, "Damaged in Railroad Fire," and postmarked December 19, 1951. Sure enough, it was Dr. Fisher's promised report. So, luckily for the Journal, the post office carried out its slogan, "the mail must go through," and though battle scarred, the report is still readable.

Reports Dean Fisher: "The Fall term at the College of Optometry of Ontario was an extremely busy one. The optometry teaching staff was placed on a full time basis—that is, part-time instructors reduced and full time instructors increased—to make more time for proper student consultation, research and lecture preparation. Staff meetings have been concerned primarily with the necessary planning for lengthening our course by one year, which goes into effect September, 1952. Before entering our College, the applicant must have five years of collegiate training (Grade XIII in Ontario). Also, substantial alterations to building facilities have been approved, steel priorities obtained and tenders are being accepted. It is anticipated the first sod will be turned about March, 1952. The addition will provide for expanded

library facilities, a new large lecture room, enlarged orthoptics clinic, new office space and a large physiology optics laboratory.

"The Board of Examiners in Optometry is offering two entering scholarships, amounting to $360.00 each, to cover all fees in the first year. These scholarships are open to all residents of the province of Ontario, although not more than one will be given to a Toronto applicant. It is hoped that further scholarships will be announced for applicants from outside the province of Ontario at an early date."

N.I.C.O. HOST FOR OCCUPATIONAL VISION SEMINAR

Northern Illinois College of Optometry will be host March 30-31 to the third A. O. A.-sponsored occupational vision seminar. Dr. Jean S. Felton, medical director, Oak Ridge National Laboratory and Dr. A. K. Peterson, medical director, Donnelly Company, Chicago, will be the featured speakers.

NEWS BRIEFS

It's "Man of the Year" time again for Jaycees all over the country, and optometry can be proud that each year an optometrist (or several) are so honored by their community. Dr. Ben F. Emanuel, South Carolina optometrist, has just been named Lancaster Man of the Year for 1951. Dr. Emanuel has been active in the South Carolina Optometric Association, Rotary, Junior Chamber of Commerce, County Board of Health, Red Cross, Memorial Youth Center, March of Dimes—quite a list in addition to a practice. He is a 1948 graduate of N. I. C. O. . . . The A. O. A. now has ready for mailing reprints of a June, 1951, *Mademoiselle* article, "Lady O.D.—A Job With Vision," recommended for distribution to vocational counselors, high school teachers, etc. . . . The clinic at the Chicago College of Optometry recently sponsored a visual screening project for the pupils of St. Michael parochial schools; discovered 14 per cent of the students studying under a visual handicap. In addition, pathological conditions needing medical attention were indicated in 2.5 per cent of the total children examined. . . . Dr. Joseph Pascal, New York City, writes that the Fourth Pan American Ophthalmological Congress held in Mexico City, was a huge success in all aspects—cultural, social and scientific. Dr. Pascal was a speaker at the Congress. . . . Armorlite Lens Company announces new cataract bifocals weighing only half as much as those of glass. Research director Robert Graham explains that these lenses are of one-piece construction with round segments 21 mm. across, and are cast from a recently developed optical resin which is highly abrasion-resistant. . . . Dr. Phillip Jackman of Hackensack was recently installed as new president of the New Jersey Optometric Association.

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